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ABSTRACT

Metric instructional units, including objectives, pretests, posttests, and resource materials, were developed for grades 1 through 5. Metric objectives and a metric test were developed for teachers. Books, charts, games, and kits used as resources in the units were evaluated according to SI guidelines. Five teachers, one from each grade level, attended an in-service program in preparation for teaching the instructional units in their classrooms. Instruction was given to 120 students. An analysis of the test data revealed that at least 60% of the teachers mastered 42% of the objectives. At least 75% of the students mastered 43% of the objectives in grade 1, 89% in grade 2, 77% in grade 3, 45% in grade 4 and 50% in grade 5. (Author/MK)

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A METRIC EDUCATION PROGRAM FOR ELEMENTARY STUDENTS

by

Carolyn H. Matthews

An Individual Practicum Report submitted in partial fulfillment of the requirements of the National Ed.D. Program for Educational Leaders, Nova University.

Henrico County Cluster
April 8, 1979

Elementary Supervisor
Henrico County Schools,
Virginia

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AUTHOR Matthews, Carolyn H.
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APR 4 1980

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I. INTRODUCTION

The writer is currently serving five schools as an elementary supervisor in the Henrico County, Virginia school system. Henrico County is a suburban county surrounding the city of Richmond on the northern, eastern, and western sides. Thirty-three thousand students are served by the school system. Sixteen thousand students are served by the thirty-four elementary schools in the county.

Six hundred students from kindergarten through the fifth grade attend Chamberlayne Elementary School, one of the schools served by the writer. Twenty-three percent of the students are black and seventy-seven percent are white. Most of the students reside in middle to upper middle class homes. The community has been served by the school for nineteen years.

Prior to the implementation of this practicum, educational activity in dealing with conversion to the metric system at the elementary school level in Henrico County had been fragmented. Limited efforts had been made to develop and coordinate a systematic approach for teaching the metric system. County developed curriculum units were not available for teachers to use for student instruction.

After an assessment was made and a need for a metric education program was established, five teachers from Chamberlayne Elementary School and their students were selected as the target population for

the practicum. The teachers agreed to attend a metric in-service program and to teach the metric instructional units which would be developed by the writer.

II. ANALYSIS OF NEED

In June 1977 the Virginia State Department of Education issued the following statement: "It is paramount that all boys and girls as well as adults in the Commonwealth of Virginia be given proper instruction in the use of SI metric units."[1] Each local school division was challenged to develop a formal plan for metric education.

Measurement permeates almost every aspect of daily life. A change to the metric system in the United States is inevitable, imminent, and already in progress or completed in some sectors of industry. America has "gone metric" in many ways although much of the population is unaware of it. A Gallup Poll showed seventy-five percent of Americans were aware of metrics. Only twenty-nine percent favored conversion, and a mere thirteen percent could give the correct number of inches in a metre.[2]

The International System of Measurement Units (SI) is a modernized version of the metric system established by international agreement. It was defined and given official status by the Eleventh General Congress of Weights and Measures in 1960. SI is also sanctioned by the

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[1] State Department of Education. Metric Education Plan for Virginia (Richmond, Virginia: State Department of Education, 1977), p. 5.

[2] Institute for Learning. Metrics in Action (Old Saybrook, Connecticut: Institute for Management, Inc., 1978), p. 1.

United States Department of Commerce and numerous educational groups. SI provides a logical and interconnected framework for all measurements in science, industry, and commerce.[3] (Throughout this report whenever the term, metric system, is used it will refer to SI units unless otherwise stated. The "re" spelling of metric words will also be used unless reference is made to a specific publication, even though the "er" spelling is accepted by many educational groups.)

SI is being used in business, industry, commerce, and trade by over ninety percent of the world's population. Public Law 93-380, which was signed into law in August 1974, states that it is the policy of the United States to encourage agencies and institutions to prepare students to use the metric system of measurement with ease and facility as a part of the regular educational program.[4]

More significantly, in the fall of 1975 the Metric Conversion Act was passed. This act declared it to be a national policy to plan and coordinate the increasing use of the metric system in the United States.[5] Metric education should be taught because of the need for an international standard of measurement, the increased use of the metric system in the United States in business and industry, and the simplicity of the metric system compared to the customary system.

Intangible benefits of going metric exist. It is very difficult for small children to learn to interpret the graduations on a

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[3]State Department of Education. Metric Education Plan for Virginia, p. 46.

[4]Ibid., p. vii.

[5]Ibid.

customary ruler. Centimetres and millimetres are conceptally much simpler than small fractions of an inch. In a study sponsored by the American Association for the Advancement of Science, it was cited that slower children learn the metric system more readily than they learn the customary system.[6]

Time could be saved if students did not have to be drilled in the fractions necessary to cope with the customary system. It has been estimated that teachers in the intermediate grades spend from fifteen to twenty-five percent of their class time teaching the details of adding, subtracting, multiplying, and dividing common fractions.[7] If the metric system, with its simpler decimal relationships were taught, teachers could rapidly give their students the basic principles of fractions and then move on to other useful aspects of mathematics.

In summary, the United States is planning to convert to the metric system because:

1. It is the only major, industrialized nation in the world not committed to the metric system.

2. It is closely linked with the rest of the world through activities such as international trade, multinational corporations, and increasing recreational travel. A common measurement system would permit the United States to communicate more easily with others in quantitative terms.

3. The United States is already metric in certain areas. Research scientists use metric measures. Medicines, film widths, and cigarette lengths are measured in metric units. Some American automobiles are built with all metric dimensions.

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[6]United States Department of Commerce. A Metric America: A Decision Whose Time Has Come (Washington, D.C.: Government Printing Office, 1971), p. 14.

[7]Ibid.

4. The metric system has a logical, natural basis using, powers of ten. Our present system is a makeshift one based on folkways. For example, in earlier times the inch was described as "three barleycorns, round and dry" when laid together.

5. The metric system is easier to learn and faster to use in computations.[8]

A recent New York Daily News opinion survey shows that metric educators have their work cut out for them. Fully forty-four percent of those surveyed said they disapproved of the changeover to metrics. Forty-four percent said they approved and twelve percent were undecided.

Respondents were also asked if they knew President Ford had signed a law committing the United States to conversion. Sixty-one percent knew and thirty-nine percent did not know. Finally, respondents were asked if they thought the United States would be ready for a full shift to metrics by 1984. Forty-two percent said yes, forty percent said no, and eighteen percent did not know.

The results of the survey do not seem to portend any great public resistance to metrics. Probably, the results reflect some understandable public uneasiness about new and changing standards of measurement.[9]

Since the primary responsibility for teaching measurement has been and is that of the schools, it is incumbent upon educators to prepare students to use the metric system. Attention must be paid to improving the quantity and the quality of metric education.

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[8]Houghton Mifflin Company. Plus 2 (Boston, Massachusetts: Houghton Mifflin Company, 1977), p. 1.

[9]Institute for Learning. Metrics in Action, p. 2.

The success of a movement toward metric education calls for the systematic development of realistic objectives designed to meet assessed needs. Certain competencies or skills are needed by teachers. The introduction of metric education in the schools must start with a program of teacher training and progress to the introduction of the metric system as the basis for the teaching of measurement in all grades.

Elementary teachers across the country who have taught the metric system feel that young children have no problem changing to and understanding metrics. Actually, a third grade teacher in a suburban Connecticut town said:

> Children in my class find metrics less complicated than our own system of measurement. The kids don't need the conversion tables, teachers do. Students, particularly in the primary grades, don't have to unlearn our present system. They simply have to learn metrics.[10]

Some of the resistance that's cropping up with respect to teaching metrics is simply that teachers are transferring their own hang-ups to their students. This is natural since almost all the teachers have spent a lifetime using the present system of measurement. Children are young, eager to learn, and ready to try something new, particularly if they are properly motivated and directed.

Since many teachers are apprehensive about working with the metric system because it is an unknown quantity and their exposure has been limited, it is vital that they learn, understand, and appreciate the metric system before trying to teach it.

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[10] Ibid.

Teachers must be careful that they do not pass on to their students their own problems of adjustment to the new system. To a student the acceptance and use of the metric system should be just one of the normal adventures in learning.

Teachers can render a service of great value to the country and set an example for the rest of the population in helping to establish the metric system and using it correctly. The metric system is a tool for all Americans to use to better measure their environment and more easily understand the relationship of its many complex parts. Formal instruction in the metric system is important because young people will help most in educating their parents and their older brothers and sisters in application of this tool to daily living.

In order to substantiate the need for a formal metric education program in the elementary schools in Henrico County, a metric survey was conducted in the six schools served by the writer during February 1978. Teacher needs and knowledge regarding metric education and the degree to which metric education is integrated in the present curriculum were assessed through the survey. The eleven principals, assistant principals, and resource teachers employed at the six schools were asked to complete the survey because of their involvement with the total curriculum. Responses are reflections of the opinions of these individuals regarding approximately 140 teachers employed in those schools participating in the survey. Survey statements follow:

1. Teachers need in-service training to assist them in developing skill in:

a. Estimating with metric units.
b. Measuring with metric units.
c. Developing student activities for their classrooms.

2. Teachers are preparing students to use the metric system with ease.

3. The development of metric curriculum units would aid teachers in providing metric instruction.

4. I would rate teachers' knowledge of:

a. The content and structure of the SI metric system as excellent, good, or poor.
b. Sources of metric curriculum materials as excellent, good, or poor.
c. Stages through which children's measurement skill and ability progress as excellent, good, or poor.

Responses to the survey are in table 1. Specific needs were noted by responses to all statements even though fifty-five percent of the respondents rated teachers as good on statement 4-c.

TABLE 1

ADMINISTRATOR AND RESOURCE TEACHER
RESPONSES TO METRIC SURVEY
EXPRESSED IN PERCENTAGES
SEPTEMBER 1978

Statement		Yes	No	No Response
1-a		100		
1-b		100		
1-c		100		
2		9	82	9
3		100		
	Excellent	Good	Poor	No Response
4-a		9	82	9
4-b	9	18	64	9
4-c		55	36	9

In September 1978, prior to the in-service program, a metric survey, attitude inventory, and pre-test were administered to the five teachers in the target group. Copies of the survey, inventory, and test are in appendixes A, B, and D.

The metric survey contained most of the statements which were on the survey conducted in the six schools during February 1978. The teachers were asked to rate themselves as excellent, above average, average, below average, or poor in six areas. Results of the survey are in table 2.

TABLE 2

TEACHER RESPONSES TO METRIC SURVEY
SEPTEMBER 1978

Statement	Excellent	Above Average	Average	Below Average	Poor	No Response
1			2	1	2	
2		1	1	2	1	
3		2	1		1	1
4		1	1		3	
5			2	3		
6			3	2		

The areas of greatest need were indicated by responses to statements 1, 2, 4, and 5. Sixty percent of the teachers rated themselves as either below average or poor on 1, estimating with metric units; 2, measuring with metric instruments; 4, knowledge of the content and structure of the SI metric system; and 5, knowledge of sources of curriculum materials. Sixty percent of the teachers rated themselves as above average or average on statement 3, indicating they felt reasonably confident about developing student activities for their classroom.

On the metric attitude inventory teachers were asked to indicate if they strongly agreed, agreed, were undecided, disagreed, or strongly disagreed with twenty-two statements. Inventory responses are in table 3.

TABLE 3

TEACHER RESPONSES TO METRIC ATTITUDE INVENTORY SEPTEMBER 1978

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	No Response
1	3	1	1			
2	1	2		2		
3				1	4	
4			1	2	2	
5	2		2		1	
6	1	2		2		
7	1	2	1		1	
8		1	1		2	1
9	1	4				
10		2	3			
11		1	3	1		
12	1	3	1			
13				3	1	
14				1	4	
15			1	3	1	
16		1		2	2	
17	1	3			1	
18	1	1	2		1	
19	2	2	1			
20		2		1	2	
21			1	2	2	
22		1	2	1		1

An analysis of the responses on the metric inventory revealed that eighty percent of the teachers strongly agreed or agreed with statements 1, 12, 17, and 19. One hundred percent of the teachers strongly agreed or agreed with statement 9. All five of these statements were related to the need for the transition to the metric system in the United States and the positive outcomes of this transition.

Eighty percent of the teachers strongly disagreed or disagreed with statements 4, 13, 14, 15, 16, and 21. One hundred percent of the teachers strongly disagreed or disagreed with statement 3.

Disagreement with the content of the seven statements supported the teachers' previous positive responses toward metrication. Even though the teachers anticipated converting to the metric system, eighty percent of them indicated thinking metric was a problem (statement 13).

The metric test, which was administered to the teachers, was based on the objectives developed by the writer during the initial stage of the practicum. The teacher objectives were classified as communication competencies, measurement competencies, problem solving competencies, or consumer competencies. An explanation of how these objectives were formulated and the criterion for mastery will be given in the implementation section of this report. The objectives were:

Communication Competencies

The teacher will:

1. Write the base unit for measuring length, mass, capacity, temperature, volume, and area.
2. Write the symbol for metre, kilometre, centimetre, millimetre, litre, gram, cubic centimetre, square metre, and degrees Celsius.
3. Identify the meaning of the prefixes milli, centi, deci, deka, hecto, and kilo.

Measurement Competencies

The teacher will:

4. Write an approximate customary relationship for metre, kilogram, litre, and centimetre.

5. Estimate length using millimetres, centimetres, metres, and kilometres.

6. Estimate mass using grams, kilograms, and milligrams.

7. Estimate volume using litres, kilolitres, and millilitres.

Problem Solving Competencies

The teacher will:

8. Use the decimal system of numeration to change metric units.

9. Solve problems involving metric units of length, mass, volume, and capacity.

Consumer Competencies

The teacher will:

10. Identify the freezing and boiling points of water, room temperature, and body temperature.

11. Identify the legal speed for driving an automobile in the city.

12. Determine the appropriate metric unit for buying goods, selling goods, or for measuring.

The objectives mastered by the teachers are in table 4.

TABLE 4

OBJECTIVES MASTERED BY TEACHERS
ON METRIC TEST
SEPTEMBER 1978

Objective	Number of Teachers Who Mastered	Percentage of Teachers Who Mastered
1	1	20
2	2	40
3		
4		
5	1	20
6		
7		
8		
9		
10	2	40
11	1	20
12	3	60

It was apparent from the metric test that, with the possible exception of objective 12, instruction was needed in all areas of the metric system. This information was used to plan activities for the in-service program which would lead to the development of teacher competency in the use of metric units.

In December 1978, prior to teaching the instructional units on the metric system, the teachers administered a metric pre-test to their students. Copies of the pre-test are in the appendixes. The metric pre-tests were designed to assess the mastery of metric objectives. An explanation of how grade level objectives were formulated and the criterion for mastery will be given in the implementation section of this report. The objectives are in appendix H. The number of

objectives for each grade and the number of objectives which were mastered by at least seventy-five percent of the students are in table 5.

TABLE 5

OBJECTIVES MASTERED BY STUDENTS
FIRST - FIFTH GRADE ON
METRIC PRE-TEST
DECEMBER 1978

Grade	Number of Objectives	Number of Objectives Mastered by at Least 75 Percent of the Students
1	7	2
2	9	3
3	13	1
4	16	
5	20	

The only objectives mastered by at least seventy-five percent of the students were:

Grade One

Objective 2 - The student will compare the relative lengths of given objects.

Objective 7 - The student will recognize a thermometer as an instrument for measuring temperature.

Grade Two

Objective 1 - The student will read and identify the words centimetre and metre.

Objective 3 - The student will compare the relative lengths of given objects.

Objective 9 - The student will read the temperature on a Celsius thermometer.

Grade Three

Objective 4 - The student will draw line segments to the nearest centimetre.

Data obtained from the surveys and pre-tests were indicative of the need for a metric in-service program for teachers and the development and implementation of a metric education program for students. Since teachers are expected to develop student awareness and a basic understanding of the metric system, it is imperative that they be given sufficient objectives, strategies, and materials for meeting these expectations. The purpose of this practicum was to develop metric instructional units for grades one through five, have these units taught at each grade level, and to evaluate the effectiveness of the units in assisting students in the attainment of specific objectives.

III. OBJECTIVES

Process

1. By September 1978 metric objectives for teachers and a pre-test and a post-test based on the objectives will be developed by the writer.

2. By November 1978 metric objectives for students in grades one through five and a pre-test and a post-test for each grade level, based on the objectives, will be developed by the writer.

3. By November 1978 the five teachers participating in the practicum will complete ten hours of in-service training, conducted by the writer, designed to develop teacher competency and confidence in teaching the metric system.

4. By November 1978 books, games, charts, and kits will be evaluated by the teachers and the writer using consistency with SI guidelines and the degree of activity as the criteria for evaluation.

5. By November 1978 metric instructional units containing a listing of resource materials will be developed for grades one through five by the writer.

6. By March 1979 the five teachers participating in the practicum will teach a six weeks unit on the metric system using the resources compiled by the writer.

Terminal

1. Ninety percent of the teachers participating in the metric in-service program will master seventy-five percent of the objectives on a metric post-test administered at the conclusion of the in-service program in September 1978.

2. Seventy-five percent of the students in grades one through five will master seventy-five percent of the objectives on a metric post-test administered at the conclusion of instruction by teachers using the metric instructional units during October and November 1978.

IV DEVELOPMENT OF STRATEGY

Literature related to metric concepts, teaching strategies, sequencing of activities, selection of materials, and in-service programs was reviewed by the writer to assist in the formulation of an appropriate strategy for the practicum. It was found that when teaching concepts of metric measurement, the teacher's primary efforts should be devoted to helping students think metric, visualizing relative size in metric units.[11]

"Think Metric" may well be the most popular slogan in the field of mathematics in the next ten years. Adoption of the metric system will institute a period of transition and adjustment. During this period, teachers should keep in mind two major objectives: (1) to continue to teach students enough about the customary system of measurement to enable them to manage those measures currently in use and (2) to familiarize students with the basic metric units of measurement in anticipation of the measures which will gradually replace those in use.[12]

Ideally, metric activities could be taught during the entire academic year as part of the regular mathematics curriculum. Or, if the teacher preferred, a unit on measurement could be periodically included.

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[11]Boyd Henry, Teaching the Metric System (Chicago, Illinois: Weber Costello, 1974), p. 9.

[12]Dorothy M. Averett, Bernice O. Crump, and Gerda I. Rosenbaum, Think Metric (New York: William H. Sadlier, Inc., 1976), p. T-3.

In either case, a hands on approach is suggested, with students involved in a variety of educational exploratory and discovery experiences to help them learn and understand the metric system of measurement.[13]

Students learn to think metric through experiences with metric units. Centimetres and kilometres will have little meaning to children or adults until they have had experiences using these units. Most educators agree that the hands on approach is the best way to learn measurement. Such activities should be experiences which recognize the level of competence of each student and build upon and expand that competence.

Appropriate experiences will guide the student to a discovery of measurement concepts and will create enthusiasm in him. Clearly, the teacher's prime responsibility in teaching the metric system is to provide opportunities for students to have direct experiences using units of the system.[14]

In a study by the American Institute for Research, it was found that two teaching strategies seemed to be the most effective in teaching the metric system. They were the hands on approach and metric immersion. Nothing succeeded so well in getting students to think metric as having them figure out their weight in kilograms, their height in centimetres, and the distance between school and home in kilometres.

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[13]Gary G. Bitter, Jerald L. Mikesell, and Kathryn Maurdeff, Activities Handbook for Teaching the Metric System (Boston, Massachusetts: Allyn and Bacon, Inc., 1976), p. 14.

[14]State Department of Education. In-Service Guide to Teaching Metric Measurement (Richmond, Virginia: State Department of Education, 1976), p. 14.

These simple exercises made metrics less of an abstract textbook exercise. The immersion technique was a "cold turkey" approach which forced students to think metric rather than stopping to convert from pounds to kilograms.[15]

Mathematics specialists are urging teachers to stress the following in teaching the metric system: (1) teach the metric system; don't teach about it and (2) have pupils use metric units of measure to learn the metric system. This focus will produce pupils who can think metric. Therefore, the teaching of comparison with and conversion to the customary system is not recommended. At all levels, the metric system should be presented as a separate and new measurement language.[16]

The choice of a strategy for teaching the metric system can enhance or impede efforts to get students to think metric. One of the commonly reported mistakes in teaching metric units is the reliance upon conversion from one system of measurement to another. Experience in countries which have changed to the metric system clearly point to faults in such strategy. Consequently, it is recommended that the conversion process between metric units and customary units be avoided. In cases where conversion is necessary, appropriate charts and tables which do not require the use of conversion formulas should be available.[17]

For many years students will see references to customary units, but increasingly these units will be replaced by metric units. It may

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[15]Richard Elwell, "The Inevitable Metric Advance," American Education (December 1976): n.p.

[16]Averett, Think Metric, p. T-3.

[17]State Department of Education. In-Service Guide, pp. 8-9.

be necessary to teach the metric system and the customary system side by side with increasing emphasis on the metric system and decreasing emphasis on the customary system. However, attempting to interweave the two systems by a tedious study and use of conversion factors is discouraged.[18] Most conversions from the customary to the metric system and vice versa are difficult. Preferably, the teaching of metrics should be taught as another measurement system.

During the changeover to metrics in the United States, it would be wise to give students a framework of equivalent measure in the customary system. For example, knowing that a litre is slightly more than a quart, etc., would be helpful rather than knowing the precise difference.[19]

In the early stages of conversion to the metric system, teachers as well as their students will have to develop bilingualism in the use of measurement languages. The metric system is really nothing more than a second language of measurement. Research that has been done on the learning of a second language seems to suggest that one learns a second language more easily by constant contact with it.

Translation between the two languages acts as a crutch which inhibits the development of skill in the second language. Translation between the two measurement languages is nothing more nor less than the use of conversion factors that has traditionally been the only, or at least the primary, attention paid to the metric system in textbooks.

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[18] Henry, Teaching the Metric System, p. 9.

[19] Bitter, Mikesell, and Maurdeff, Activities Handbook, p. 14.

For a time, at least, teachers will no doubt feel much more comfortable using the customary system than the metric system. Many students will also experience this dissonance as first experiences with metric units are encountered. Students in the upper grades will have established a good working relationship with customary units; so that there will be a natural tendency for them to want to measure, or at least, think in customary terms and then convert. Such tendencies should be discouraged, otherwise teachers will be encouraging students to develop skills which will be obsolete in a few years.

A skill which will be needed to develop fluency in the metric system is the manipulation of decimals. Many students, at the time of their initial exposure to metric units, will have had almost no exposure to decimal numerals, much less to manipulation of decimals under the standard operations. For these students, the development of decimal notation should proceed concurrently with metric activities.[20]

Because the metric system is based on powers of 10 there will be more emphasis on the teaching of decimals to students at an earlier age. More attention will also be given to the teaching of place value and extending the student's knowledge of working with the powers of 10. This, in turn, will bring about a decrease in instruction of fractions.[21] Extensive work with fractions has typified much of the elementary school mathematics curriculum for many decades. As metrication proceeds, there

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[20]George W. Bright, "Metrics, Students, and You," Instructo (October 1974): n.p.

[21]Bitter, Mikesell, and Maurdeff, Activities Handbook, p. 14.

will probably be a noticeable drop in the amount of attention given to developing this skill.[22] Fractions more than likely will be included in the upper grades rather than their current place in the curriculum.

The concepts that measurement is approximate and units of measure must be of the same nature as what is being measured are often overlooked in the teaching of measurement. These concepts must be kept in mind when the metric system is taught. The teacher will need to carefully select appropriate measuring experiences to insure that the student is capable of performing and understanding the concepts.[23]

Jean Piaget believes that measurement is a synthesis of the operations of subdivisions into parts and of substitution of a part upon others. The ability to measure develops later than the number concept because it is more difficult to divide a continuous whole, such as an object being measured, into interchangeable subunits than it is to count a set of objects that are separate and discrete from each other, such as beads or blocks.

Necessary concepts develop from within rather than from without for operational understanding. Piaget believes children cannot be told how to measure; they should be provided with appropriate materials and be allowed to experiment and to try to solve measurement problems for themselves. The necessary concepts will develop when the child is old enough and when he is allowed to experiment with objects used in measurement.

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[22]Bright, "Metrics, Students, and You," n.p.

[23]Bitter, Mikesell, and Maurdeff, Activities Handbook, p. 14.

When providing measurement learning experiences two important ideas should be kept in mind: (1) Measurement is by nature a hands on activity in which children need to get personally involved and (2) Many concrete, exploratory activities should precede measurement using standardized tools.[24]

Metric measurement activities can be an integral part of the mathematics curriculum at all grade levels. Exploring and discovering metric concepts through activities can involve students at all levels. The emphasis in the primary grades should be on exploring metric measures. Measurement activities will introduce the meaning of measurement, help the students discover a need for standardized units, and introduce the common units of measure and the tools used to measure.

The emphasis in the intermediate grades should be on discovering metric measures. Measurement activities can help students understand the importance of measurement in daily activities. The history of measurement could be discussed, measurement concepts refined, vocabulary extended, and students taught to use measuring instruments with increasing skill.[25]

The metric system is merely a system of measurement that replaces another system of measurement. Metrication provides the opportunity to: (1) reevaluate the measurement component of the mathematics curriculum, (2) reconsider what is known from experience and from research about how children learn measurement concepts, and (3) restructure the curriculum and modify instructional practices. When

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[24]Jean Piaget, "How Children Form Mathematical Concepts," Scientific American (November 1953): 78.

[25]Bitter, Mikesell, and Maurdeff, Activities Handbook, pp. 17-18.

planning a program, Marilyn Suydam states that the following scope and sequence should be considered:

Primary Level

1. Development of the basic prerequisite skills and understanding about measurement
2. Extension of the concept of measurement by using nonstandard (arbitrary) units
3. Introduction of the various standard units of the metric system and the instruments used to measure in these units

Intermediate Level

1. Development of the relationships between the prefixes, stressing the relationship to the decimal system
2. Introduction of the metric symbols
3. Teaching the relationships of measures
4. Development of the understanding of rectangular solids
5. Conversion from one metric measure to another
6. Introduction of addition and subtraction with common measures
7. Development of angle measures
8. Working with metric units in problems
9. Development of the understanding of the relationships among units for length, volume, and mass
10. Development of the idea of accuracy and precision of measurements and of significant digits
11. Extension of time and temperature concepts[26]

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[26]National Council of Teachers of Mathematics. A Metric Handbook for Teachers (Reston, Virginia: National Council of Teachers of Mathematics, 1974), p. 81.

Since schools are already beginning to work with metrics, there is an increasing need for teaching materials. Initially, supplementary booklets were published for use with textbooks already on the market. Because it is difficult to sequence instruction in supplementary materials, teachers should take care in the selection of materials for use in the schools.

Publishers are also beginning to discuss significant textbook revisions to accommodate the inclusion of the metric system as the primary language of measurement. The first phase of this process is the substitution of metric measurement activities (or joint customary-metric activities) for the existing work with the customary system. Dual measurement exercises should be carefully constructed to lessen the chance that students will compare the two systems and thus focus on conversions between them.[27]

A change in measuring units necessitates a change in materials and equipment. Many of the devices needed to teach measurement can be made by the teacher or by students in the classroom, thus providing an excellent teaching activity. There is a need, nevertheless, for schools to purchase some metric materials and metric measuring devices.

Commercial publishing companies, being aware of federal legislation, anticipated the market for new metric materials and equipment. As a result, a plethora of materials, many of inferior quality were produced. Hence, when choosing metric materials consideration should be given to quality and appropriateness.[28]

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[27]Bright, "Metrics, Students, and You," n.p.

[28]State Department of Education. Metric Education Plan for Virginia, p. 52.

In the study conducted by the American Institute for Research, it was found that because there is money in metrication, commercial suppliers were quicker to identify potential education markets than they were to produce pedagogically sound materials with correct metric symbols and abbreviations. When the Australian State Education Department reviewed materials, such as commerical metric games and charts, it had to reject most of them because they were inappropriate.[29]

Learning games were first developed by educators and others in an attempt to associate enjoyment with learning. Learning games may be defined as a small group activity in which players use or acquire knowledge, skills, and attitudes as they compete with other players under specified conditions and rules.

Used as an instructional tool, metric games can effectively teach students in a variety of areas simultaneously. Basic measurement and estimation skills can be learned and practiced through games. Knowledge and practical application of the metric system can be gained.

Metric learning games facilitate cognitive learning, enhance skill development, act as a source of motivation, and effect other variables in the educational environment which have considerable impact on learning the metric system. The "play" aspect of games is crucial to their success. "Play" certainly should not connote superficiality, but rather a lively sense of curiosity and imagination which makes learning exciting.[30]

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[29]Diane Brundage, "Some Dos and Don'ts in Metric," American Education (December 1976): n.p.

[30]Institute for Learning. Metrics in Action, pp. 1-2.

Games seem to fit well into classrooms where the learning center approach is used. This is related to the feature that games can be operated independent of direct teacher control, thus freeing the teacher to observe and provide individual pupils with assistance on the same or related content.[31]

Because teachers have the primary responsibility for instruction they must be aware of metric measurement and be prepared to use it in their classrooms. The Virginia State Department of Education recommended that by July 1, 1979 all educational personnel in the Virginia public schools participate in a metric measurement in-service program ranging from three to sixteen hours. The number of hours for in-service instruction would be planned according to job classification. Eight to twelve hours were recommended for elementary teachers; sixteen hours were recommended for teachers in the intermediate grades.[32]

Most experts feel that eight to fifteen hours is sufficient to properly train teachers.[33] The United States Metric Study estimates that only a few hours of training will be needed to prepare teachers for teaching the metric system.[34] One of the recommendations from the Interstate Consortium on Metric Education report

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[31]National Council of Teachers of Mathematics. A Metric Handbook for Teachers, p. 45.

[32]State Department of Education. Metric Education Plan for Virginia, p. 5.

[33]Jeffrey V. Odom, "The Metric System: Learn It, Think It, Teach It," Instructo (October 1974): n.p.

[34]Houghton Mifflin Company. Plus 2, p. 3.

follows: "ICME recommends that measurement in-service programs for individuals directly involved in teaching measurement to students be 10-16 hours. . . . hands on activities should be emphasized."[35]

The American Institute for Research, with funding from the National Institute of Education, studied the impact of metric conversion on the educational systems of England, Australia, New Zealand, South Africa and Canada. Whether or not the five countries succeeded in providing enough metric training for teachers remains a debatable question. In the process of trying, however, their educators discovered five important strategies:

1. Launch metric awareness and orientation programs well in advance of the actual training so that teachers will feel less anxious about the new system and begin to see its simplicity and advantages

2. Schedule training in short sessions over a given time, alternating the sessions with classroom tryouts of materials and methods, and keep in mind that one-shot crash courses are less effective

3. Have teachers learn the system by making materials they will later use in their classrooms

4. Coordinate training so that a session is scheduled just before teachers will be called upon to use it because information given too far in advance is quickly forgotten

5. Offer teachers a generous dose of immersion and hands on experiences so they can feel comfortable themselves with the system and its inner logic rather than leaning on the dual system approach.[36]

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[35] State Department of Education. In-Service Guide, p. 19.

[36] Brundage, "Some Dos and Don'ts in Metric," n.p.

Individuals who were knowledgeable in metric education were consulted by the writer to ascertain procedures which could be used in the development and implementation of a metric education program. A meeting was held with Dr. Daniel Yates, curriculum specialist at the Math-Science Center in Henrico County, to discuss the approach which should be used to teach the metric system. Dr. Yates felt that an activity approach should be used. He emphasized the importance of providing opportunities for teachers and students to manipulate measurement instruments and suggested specific measurement instruments which should be purchased for primary and intermediate students.

A telephone conversation was held with Midge Washburn, elementary math supervisor in the Chesterfield County, Virginia school system. Mrs. Washburn explained how the metric education program in Chesterfield County had evolved from the county's five-year plan. Developing parental awareness of the metric program in the schools was cited as part of the county's plan. This had been done in some of the schools through a workshop at night for parents and the development of a handbook of metric activities for parents.

Mrs. Washburn emphasized continuing to teach the customary system as well as the metric system to students in the intermediate grades. She expressed a preference for teaching the metric system as a unit rather than integrating it in the curriculum throughout the school year.

Several telephone calls were made to Edgar Edwards, associate director of mathematics in the State Department of Education, to

request metric curriculum guides and other metric materials. The writer attended an all day leadership training institute on metric education conducted by Mr. Edwards. The purpose of the institute was to provide an opportunity for state department personnel to share information on organizing and initiating an in-service training program on metric measurement and to present how the publication, Metric Education Plan for Virginia, might be used for effective curriculum planning.

The writer attended a presentation on the metric system by Dr. Fred Haus, a professor at Virginia Commonwealth University and author of Living in a Metric America. His presentation focused on the need for adhering to SI guidelines when using or teaching the metric system. Dr. Haus believed SI symbols, punctuation, and spelling of metric measurement words should be taught as soon as students begin developing metric concepts.

Dr. Haus' opinion was reinforced by Julis Kriss, science materials specialist from Fairfax County, Virginia, at a workshop presented at the National Council of the Teachers of Mathematics Conference. This workshop was designed for individuals who were already familiar with SI and focused on the development of interdisciplinary activities to make "think metric" an everyday part of the curriculum. Suggestions concerning the purchasing of metric materials consistent with SI were made by Mrs. Kriss. This workshop was especially beneficial to the writer since she had completed much research on the metric system and had already taken a metric course.

An analysis of the research conducted for this practicum revealed two areas in which there was general agreement among the experts in metrication: (1) to encourage teachers and students to think metric, thereby avoiding conversion from one measurement system to another and (2) to employ a hands on activity approach to the teaching of metrics. Using these findings as a base, the strategy for the practicum was selected.

Since research indicated the metric system could be taught as a unit or integrated in the curriculum throughout the school year, a unit presentation was selected. This choice was made because the writer felt teachers would be more receptive to the unit presentation. The integrated approach would be more appropriate after teachers had acquired confidence in teaching the metric system.

A decision was made to develop metric instructional units for each grade level composed of three components: (1) objectives, (2) pre- and post-tests, and (3) a listing of metric books, charts, games, and kits. Resource materials would be evaluated using consistency with SI guidelines and the degree of activity as the criteria for evaluation.

The in-service program for teachers would be ten hours and would concentrate on metric skills in the areas of length, mass, volume, and temperature. Emphasis would be on thinking metric and using an activity approach. The in-service program would also be designed to give teachers an overview of the history of the metric system, and understanding of why the changeover to the metric system is necessary in the United States, and techniques for presenting the

metric system to students. A pre-test and a post-test based on teacher competencies in metric measurement would be developed and administered to the teachers prior to the in-service program and at the conclusion of the program.

Teachers would be asked to teach the instructional units as soon as they completed the in-service program. The writer would observe in the classrooms as the teachers were teaching the units and would hold conferences with the teachers as they progressed through the units. After the units were completed, the writer would make revisions in the units based on teacher recommendations.

V. IMPLEMENTATION OF STRATEGY

Activities and materials necessary for implementation of the practicum were discussed with the director of elementary education. Approval was given for conducting the practicum and for purchasing in-service training materials, metric instructional materials, and equipment for students.

After approval was granted, a conference was held with the administrators at Chamberlayne Elementary School to discuss the purpose of the practicum and teacher and student involvement. The writer and the principal of the school jointly selected the five teachers who would be asked to participate in the practicum. One teacher was selected from each grade level. None of the teachers selected had taken a metric course.

A conference was held with each of the teachers in September 1978 to explain the practicum and to determine those teachers who were willing to participate in practicum activities. All of the teachers were receptive to the ideas presented and agreed to teach the instructional units. The following points were made at each conference:

1. The in-service program would last ten hours and would be held on days which were most convenient for the teachers

2. An activity approach would be used in teaching the in-service program

3. Teachers would have to take a pre-test and a post-test to determine if metric objectives had been mastered

4. All materials necessary for teaching the units would be provided for the teachers

5. Teachers would be asked to assist in evaluating metric materials and to make recommendations for revising the instructional units

Measurement competencies and goals defined by the State Department of Education were used as a basis for the development of teacher objectives. Goals recommended by the state are:

The participant will:

1. Develop awareness of and the need for the use of the metric system

2. Become aware of the simplicity of the metric system

3. Realize that he already uses some measures of the metric system

4. Reinforce his realization of the importance and extensive need for measurement ideas and skills

5. Review what it means to measure, become aware of some of the basic assumptions concerning measurement, and review the need for standardized measures, what measurement involves, and the concept of accuracy and precision

6. Review the International System of Measurement: numeration system relationships, prefixes, symbols, etc., with physical and comparative referents, across measures

7. Become aware of those components of the metric system which are commonly used

8. Develop awareness of various types of consumer applications

9. Extend understanding of metric measures which include the ability to read instruments which are metrically scaled

10. Become aware of various specialized applications of measurement using the metric system

11. Determine the measurement ideas, using the metric system, which may be taught to students at various grade levels

12. Review some "do's and don'ts" for teaching SI units

13. Have experiences with measurement using the metric system.[37]

Teacher objectives were classified as communication competencies, measurement competencies, problem solving competencies, and consumer competencies. The twelve objectives are in appendix C.

A metric test was developed for teachers based on the objectives. The number of test items varied according to the content of the objective. The criterion for mastery was the number of items which were correctly answered for each objective. Mastery was one correct item out of one, three out of four, four out of five, five out of six, six out of eight, or seven out of nine. The objective numbers, number of test items for each objective, and the mastery level are in appendix F.

An analysis of the objectives revealed that specific information was required to master six (fifty percent) of the objectives. A decision was made at this time to use the same test both as a pre-test and as a post-test.

Prior to the development of metric objectives for students, county curriculum guides and basal textbooks were reviewed to determine

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[37]State Department of Education. In-Service Guide, pp. 19-20.

their metric content. The two subject areas which were scrutinized were mathematics and science.

Metric objectives were not listed in the mathematics nor science curriculum guides; however, the county adopted science program contained references to the metric system in the teacher's edition of the textbook. These references were intended to serve as an aid to the teacher in explaining a section of the student's textbook in metric terms. Each level of the Holt Elementary Mathematics series, the county adopted mathematics program, contained metric objectives and activities for students. In most instances, the metric system was taught parallel with the customary system.

Another source reviewed was the Basic Learning Skills (BLS), minimum objectives established at the state level for all students in the elementary grades. Metric related objectives included in the BLS are in appendix G. Metric objectives published by Instructional Objectives Exchange were also used as a guide in developing student objectives.[38] Student objectives for each grade level, developed by the writer, are in appendix H.

Pre-tests and post-tests for each grade level were developed based on the objectives. Copies of the tests are in the appendixes. With the exception of the second grade tests, all test item numbers correspond with the objective numbers. Objective numbers for the second grade tests and the items used to determine if an objective had been mastered are in appendix HH.

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[38]Instructional Objectives Exchange. Metric Measurement: Grades K-8 (Los Angeles, California: Instructional Objectives Exchange, 1977).

The criterion for mastery was the number of items which were correctly answered for each objective. Mastery was one correct item out of one, two out of two, three out of three, three out of four, five out of six, five out of seven, or six out of eight. The objective numbers, number of test items for each objective, and the mastery level are in appendix GG.

In preparation for developing the in-service program and instructional units metric books, games, kits, and charts were ordered from leading publishers of metric materials. Some materials were purchased directly from local sales representatives. To assist in securing appropriate materials, the writer reviewed metric materials at the State Media Center.

Books, games, kits, and charts were evaluated using consistency with SI guidelines and the degree of activity as the criteria for evaluation. Guidelines for the spelling, punctuation, and the use of symbols are given in appendix SS. The evaluation of metric books is in appendix II; the evaluation of games, charts, and kits is in appendix JJ.

Resource materials for the instructional unit for each grade level were listed under eight topics: (1) Introduction to Metrics, (2) Length, (3) Perimeter, (4) Area, (5) Mass, (6) Volume, (7) Temperature, and (8) Combination of Areas. Student objectives for each grade level were used as a major factor in determining the placement of resource materials. The metric instructional units are in appendixes LL through PP. Appendixes QQ through VV contain reference materials which were compiled for the teachers.

In the summer of 1978 tentative plans for the in-service program were formulated. The purpose of the in-service program was to develop teacher awareness of the metric system and to develop teacher competency in metric skills in the areas of length, mass, and volume.

Approximately ten hours of instructional time were planned. Instructional sessions would be held from 2:30 P.M. - 4:00 P.M. one day each week, for seven weeks, beginning the end of September. Teachers would select the day which they preferred to meet. During the September conferences, most of the teachers said they would prefer to meet on Monday of each week.

Plans for the in-service program were finalized after conferring with the teachers and administering the metric inventory, survey, and test to the teachers. Data obtained from the inventories, surveys, and tests were used in planning specific activities for the in-service program.

In-service sessions, conducted by the writer, were held in the Chamberlayne Elementary School Library. Dates for the sessions and topics follow:

September 27

In-Service Overview
History of the Metric System
Need for United States Conversion
SI Guidelines

October 5

Length
Perimeter
Area

October 10

Volume

October 16

Relationship of Volume and Mass

October 30

Mass

November 6

Temperature
Review of Metric Games

November 13

Review of Length, Volume, and Mass

Teachers were involved in the following activities:

1. Taking personal measurements
2. Making estimations and verifications
3. Selecting appropriate units for measuring
4. Measuring with metric instruments
5. Converting within the metric system
6. Writing symbols for metric units
7. Using the decimal system of numeration
8. Determining the appropriate metric unit for buying or selling goods
9. Solving metric word problems
10. Reviewing metric materials and games
11. Playing metric games

12. Viewing a slide presentation on the metric system

13. Compiling a metric notebook of handouts, booklets, and activities. (Appendix WW contains a list of some of the materials which were given to the teachers during the in-service program.)

At the conclusion of the in-service program a conference was held with each teacher. Questions asked and a summary of the replies follow:

1. What are your suggestions for improving the in-service program?

   The teachers were satisfied with the in-service program and particularly liked use of the activity approach. They felt exposure to the metric materials and games would be an asset to them in teaching units in their classrooms. Even though the in-service program had been structured to deal with one area of measurement at the time, the teachers indicated the areas had overlapped at times and additional time was needed for certain topics.

2. What did you think of the metric test for teachers?

   The use of a test for accessing metric knowledge and progress was considered a positive aspect of the in-service program. Two teachers said the test was difficult. The suggestion was made for questions on linear measurement to be more relevant to teacher experiences.

3. Do you have any concerns related to teaching the metric unit in your classroom?

   The teachers were looking forward to teaching the units in their classrooms. They thought they would feel more comfortable with the metric system after they had taught the units. The fourth grade teacher was concerned that her students might become frustrated with the metric pre-test. She decided to test the students on five of the easiest objectives.

Student objectives, tests, instructional units, books, games, charts, kits, and metric measuring instruments were given to the teachers prior to the teaching of the units in the classroom. Measuring instruments included the following:

1. metre sticks
2. tape measures
3. millimetre rulers
4. centimetre rulers
5. measuring lines
6. centimetre cubes
7. primer balance
8. litre pan balance scales
9. metric scales
10. personal scales
11. spring scales
12. stacking masses
13. kilogram mass
14. volume set
15. measuring spoons
16. measuring cups
17. bow calipers
18. indoor thermometer
19. outdoor thermometer

Approximately $280 was spent on books, $200 on games, charts, and kits, and $225 on measuring instruments for a total of $705. Money

from the writer's annual budget through the department of elementary education was used to purchase all materials.

Teachers began teaching the metric units in December 1978 and concluded them in February 1979. The time spent on the units ranged from six to twelve weeks. The writer made at least two observations in each teacher's classroom while the metric units were being taught.

Teachers in grades one through three emphasized an activity approach to a greater extent than teachers in grades four and five. Metric learning stations or centers were used by three teachers as a major mode for presenting metric concepts. Through classroom observation the writer noted the following:

1. Metric posters, both commercial and teacher made, were displayed in the classrooms.
2. The height of the students in centimetres was recorded on an Uncle Sam wall chart.
3. Library books on the metric system were placed in reading corners.
4. Students made metric measuring instruments.
5. Students played metric games to reinforce metric concepts.
6. Notebooks of metric activities were kept by the students.
7. Teachers developed and administered tests for the areas of metric measurement.
8. Students worked in pairs and small groups.
9. Games using metric measurements were played during physical education.
10. Students learned a metric song.

11. Metric words were listed as required spelling words for the week.

12. The math textbook was used as a reference.

13. Students brought items from home that were labeled in metric terms.

14. Students were given metric assignments for homework.

15. Metric television programs were used.

16. Students measured with metric instruments during their free time.

Most of the students appeared to be at ease when working with the metric system. During one lesson a student said, "Mrs. _____, after we learn this we'll have to go home and show our mothers and dads how to do this." As an outgrowth of the metric unit, students in the fifth grade made metric games and activities which were displayed at a local math conference. Two teachers who were not involved with the practicum asked the writer to share the metric materials with them.

During the period while the metric units were being taught, the writer held conferences with the teachers to discuss problems and concerns. The following items were discussed:

1. Scheduling and length of metric lessons
2. Recording test results
3. Use of measuring instruments
4. The desirability of teaching the customary system and metric system
5. How to answer parental questions
6. Making provisions for slow students

After the units were completed and post-tests were administered, a conference was held with each teacher to discuss student objectives, tests, and materials. All of the teachers thought the grade level objectives were realistic and attainable by students. Teachers in grades three, four, and five indicated that prior exposure to metric concepts in earlier grades would increase the likelihood that more students would master the objectives.

The fifth grade teacher suggested that the unit be taught throughout the school year parallel with the customary system. The remainder of the teachers felt comfortable with the six to twelve weeks approach.

A variety of resources listed in the units were used by the teachers. Most of the teachers indicated they preferred the activity approach, even though they had not used this approach to the extent which they desired. Metric recipes had been taken home by the students to get parents involved in the metric units. The teachers felt this particular activity had increased parental support for the teaching of metrication in the school.

Generally, the teachers felt they had grown professionally by teaching the metric units. One teacher stated, "I've learned more through working with my students than I did in the in-service sessions." Even though the students did not master many of the objectives, the teachers indicated that the units were beneficial and they felt pleased with the test results.

VI. EVALUATION

Process Objectives

1. By September 1978 metric objectives for teachers and a pre-test and a post-test based on the objectives will be developed by the writer.

Twelve objectives were developed and classified in four categories: (1) communication competencies, (2) measurement competencies, (3) problem solving competencies, and (4) consumer competencies. Three objectives were in category 1, four in category 2, two in category 3, and three in category 4.

While the writer was developing the metric pre-test, it was noted that specific information was required to master six (fifty percent) of the objectives. For example, objective 1, writing the base unit for measuring length, mass, capacity, temperature, volume, and area; and objective 3, identifying the meaning of the prefixes milli, centi, deci, deka, hecto, and kilo did not allow for any variance in test construction. A decision was made to use the same test both as a pre-test and as a post-test. The metric test was composed of seventy items.

2. By November 1978 metric objectives for students in grades one through five and a pre-test and a post-test for each grade level, based on the objectives, will be developed by the writer.

Metric objectives were developed for each grade level. Seven objectives were developed for grade one, nine for grade two, thirteen for grade three, sixteen for grade four, and twenty for grade five. Most of the objectives were related to length, volume, mass, and temperature. BLS objectives were incorporated in the grade level objectives.

A pre-test and a post-test for each grade level, based on the objectives, were developed. Grade one tests contained twenty-five items, grade two twenty-nine items, grade three forty-four items, grade four seventy-six items, and grade five ninety-two items, Oral directions were developed for tests in grades one and two. Tests for grades three, four, and five were designed to be read by the students.

3. By November 1978 the five teachers participating in the practicum will complete ten hours of in-service training, conducted by the writer, designed to develop teacher competency and confidence in teaching the metric system.

Seven, one and one-half hour metric in-service programs were conducted by the writer. Sessions were held on September 27, October 5, October 10, October 16, October 30, November 6, and November 13 for a total of ten and one-half hours of instruction.

The teachers completed a metric survey and an attitude inventory prior to the in-service program and at the conclusion of the program. Results of the final survey are in table 6; results of the initial survey were previously given in table 2. The results of the surveys were compared to access the effect of the in-service program on the teachers.

TABLE 6

TEACHER RESPONSES TO METRIC SURVEY
NOVEMBER 1978

Statement	Excellent	Above Average	Average	Below Average	Poor	No Response
1		1	2	2		
2	2		3			
3	1	2	1			1
4		2	1	2		
5	1	1	3			
6			4	1		

On the final survey forty percent of the teachers rated themselves as excellent and sixty percent rated themselves as average on statement 2, measuring with metric instruments. On the initial survey forty percent of the teachers had rated themselves as below average and twenty percent had rated themselves as poor on statement 2. On the final survey twenty percent of the teachers rated themselves as excellent, twenty percent as above average, and sixty percent as average on statement 5, knowledge of sources of curriculum materials. Initially forty percent of the teachers had rated themselves as average and sixty percent as below average on statement 5. Responses to all six statements were more positive on the final survey than on the initial survey; however, more significant changes were noted on statements 2 and 5.

Results of the final attitude inventory are in table 7; results of the initial attitude inventory were previously given in table 3.

TABLE 7

TEACHER RESPONSES TO METRIC
ATTITUDE INVENTORY
NOVEMBER 1978

Statement	Strongly Agree	Agree	Undecided	Disagree	Strongly Disagree	No Response
1	2	2	1			
2		2	1	2		
3				2	3	
4			1	2	2	
5	1	1		3		
6		2	1	2		
7	2		2	1		
8		1		3	1	
9	1	4				
10	2	2		1		
11		3		1	1	
12	1	2	1	1		
13		4		1		
14				3	2	
15			1	2	1	1
16		1		3	1	
17		4			1	
18	1	2	1	1		
19	1	2		1		1
20		1		2	1	1
21				3	2	
22	1	3	1			

On the initial inventory teachers generally indicated positive responses toward metrication. An analysis of the results of the two inventories revealed insignificant changes in teacher responses except for statement 13. On the initial inventory eighty percent of the teachers disagreed or strongly disagreed with statement 13, Thinking metric is no problem for me. On the final inventory eighty percent of the teachers agreed with statement 13 which is indicative of

the role the in-service program had in helping teachers think in metric terms.

The development of teacher competency through the in-service program will be discussed under terminal objective 1.

4. By November 1978 books, games, charts, and kits will be evaluated by the teachers and the writer using consistency with SI guidelines and the degree of activity as the criteria for evaluation.

Books, games, charts, and kits were evaluated according to the established criteria. Thirty books were evaluated and twenty-four games, charts, and kits. Forty-seven percent of the books were consistent with SI guidelines, forty-three percent were partially consistent, and ten percent were inconsistent. Seventy-three percent of the games, charts, and kits were consistent with SI guidelines and thirty-seven percent were partially consistent. All of the games, charts, and kits were activity-oriented.

5. By November 1978 metric instructional units containing a listing of resource materials will be developed for grades one through five by the writer.

Instructional units were developed for grades one through five using student objectives as a guide for the placement of resource materials. Materials were listed under eight topics and included metric books, games, charts, kits, and educational television programs.

6. By March 1979 the five teachers participating in the practicum will teach a six weeks unit on the metric system using the resources compiled by the writer.

The five teachers taught the instructional units between December 1978 and February 1979. Teachers spent from six to twelve weeks teaching the units. The writer observed each teacher a minimum of two times while the instructional units were being taught.

Process objectives 1 through 6 were met to the degree desired by the writer.

Terminal Objectives

1. Ninety percent of the teachers participating in the metric in-service program will master seventy-five percent of the objectives on a metric post-test administered at the conclusion of the in-service program in September 1978.

This objective was evaluated by reviewing the results obtained on the post-test which was administered to the teachers at the conclusion of the in-service program in November 1978. Pre-test and post-test results are in table 8.

TABLE 8

OBJECTIVES MASTERED BY TEACHERS
ON METRIC PRE-TEST AND POST-TEST
SEPTEMBER AND NOVEMBER 1978

Objective	Percentage of Teachers Who Mastered Objectives On Pre-Test	Percentage of Teachers Who Mastered Objectives On Post-Test
1	20	40
2	40	60
3		80
4		40
5	20	60
6		40
7		20
8		40
9		40
10	40	80
11	20	40
12	60	60

The results of the initial testing and final testing were compared to determine progress made toward the attainment of teacher objectives.

Objectives 3 and 10 were mastered by eighty percent of the teachers in November. On the initial test in September none of the teachers mastered objective 3 and only forty percent mastered objective 10. Sixty percent of the teachers mastered objectives 2, 5, and 12 in November. Objectives 4, 6, 8, and 9 were mastered by forty percent of the teachers in November. None of the teachers mastered these objectives in September. There was an increase in the percentage of teachers who mastered each objective, with the exception of

objective 12. The percentage of teachers who mastered this objective was sixty percent in September and in November.

In November only twenty percent of the teachers mastered objective 7, estimating volume using litres, kilolitres, or millilitres. This was probably one of the most difficult areas of measurement taught during the in-service program. It was apparent during the in-service program that teachers were having difficulty acquiring concepts related to volume, especially in estimating.

More teachers mastered the objectives most applicable to daily living. These objectives included: 2, writing the symbols for metric terms; 3, identifying the meaning of prefixes; 5, estimating length; 10, identifying common temperatures; and 12, determining the appropriate metric units for buying goods, selling goods, or for measuring.

Too many concepts were presented in the in-service program. A comprehensive program, including instruction in all phases of metric measurement should last more than ten hours. Fifteen to eighteen hours would be desirable. Recommendations for improving the in-service program would include limiting the number of areas taught during a ten-hour program or extending the length of time for the in-service program.

Terminal objective 1 was not met. None of the objectives were achieved by ninety percent of the teachers. A more realistic objective would have been that eighty percent of the teachers would master seventy-five percent of the objectives.

2. Seventy-five percent of the students in grades one through five will master seventy-five percent of the objectives on a metric

post-test administered at the conclusion of instruction by teachers using the metric instructional units during October and November of 1978.

This objective was evaluated by reviewing the results obtained on the metric post-tests which were administered to students in grades one through five after the metric instructional units were taught. Post-tests results for each grade level as well as pre-tests results are in tables 9 through 13.

TABLE 9

OBJECTIVES MASTERED BY FIRST GRADE
STUDENTS ON METRIC PRE-TEST
AND POST-TEST
DECEMBER 1978 AND MARCH 1979

Objective	Percentage of Students Who Mastered Objectives on Pre-Test	Percentage of Students Who Mastered Objectives on Post-Test
1	54	50
2	100	95
3	20	29
4	20	50
5	37	29
6	54	83
7	95	100

Number tested 24

Three of the seven objectives (forty-three percent) were mastered by at least seventy-five percent of the students in grade one. Two of the three objectives, objectives 2 and 7, were also mastered by a high percentage of the students on the pre-test. A significant

increase in the percentage of students who mastered objectives on the post-test compared to the pre-test was noted on objectives 4 and 6.

Objective 3, finding the length of objects using arbitrary units, and objective 5, recognizing a litre container as an instrument for measuring liquids, were mastered by a small percentage of the students. A review of the student test booklets indicated students had not understood the oral directions. Many students had counted the dots rather than using their fingers to measure the lines. Objective 5 was probably not mastered by a high percentage of the students because the teacher indicated she did not provide many experiences for students with liquid measurement. Although terminal objective 2 was not met by the first grade students, progress was made on five of the seven objectives.

TABLE 10

OBJECTIVES MASTERED BY SECOND GRADE STUDENTS ON METRIC PRE-TEST AND POST-TEST DECEMBER 1978 AND MARCH 1979

Objective	Percentage of Students Who Mastered Objectives on Pre-Test	Percentage of Students Who Mastered Objectives on Post-Test
1	83	100
2		91
3	100	87
4	70	95
5	25	62
6		100
7	62	95
8		87
9	100	100

Number tested 24

Eight of the nine objectives (eighty-nine percent) were mastered by at least seventy-five percent of the students in grade two. Four of the eight objectives were mastered by a high percentage of the students on the pre-test. Six of the nine objectives were mastered by at least ninety percent of the students on the post-test.

There were significant increases in the number of students who mastered objectives 1, seventeen percent; 2, ninety-one percent; 4, twenty-five percent; 5, thirty-seven percent; 6, one hundred percent; 7, thirty-three percent, and 8, eighty-seven percent. Objectives 2, 6, and 8 involved the writing of metric symbols, a skill which is readily acquired by most students after formal instruction.

The objective mastered by the smallest percentage (sixty-two) of the students was objective 5, reading and identifying the word litre. A review of the student test booklets revealed that twenty-two of the twenty-four students could read the word litre, but only sixteen of the students could identify the word.

Terminal objective 2 was met by the second grade students.

TABLE 11

OBJECTIVES MASTERED BY THIRD GRADE
STUDENTS ON METRIC PRE-TEST
AND POST-TEST
DECEMBER 1978 AND MARCH 1979

Objective	Percentage of Students Who Mastered Objectives on Pre-Test	Percentage of Students Who Mastered Objectives on Post-Test
1		75
2	43	95
3	69	85
4	82	100
5	8	75
6	13	85
7		40
8	4	85
9	4	70
10		70
11		80
12	4	95
13	4	75

Number tested 23 - Pre-test
20 - Post-test

Ten of the thirteen objectives (seventy-seven percent) were mastered by at least seventy-five percent of the students in grade three. One of these objectives was mastered by a high percentage of the students on the pre-test. Three of the thirteen objectives were mastered by at least ninety percent of the students on the post-test.

There were significant increases in the number of students who mastered objectives 1, seventy-five percent; 2, fifty-two percent; 5, sixty-seven percent; 6, seventy-two percent; 8, eighty-one percent; 9, sixty-six percent; 10, seventy percent; 11, eighty percent; 12,

ninety-one percent; and 13, seventy-one percent. Two of the objectives, 7 and 9, which were not mastered by seventy-five percent of the students involved millilitres and litres. Objective 10, which was mastered by seventy percent of the students, involved reading and identifying the words gram and kilogram.

Terminal objective 2 was met by the third grade students.

TABLE 12

OBJECTIVES MASTERED BY FOURTH GRADE STUDENTS ON METRIC PRE-TEST AND POST-TEST DECEMBER 1978 AND MARCH 1979

Objective	Percentage of Students Who Mastered Objectives on Pre-Test*	Percentage of Students Who Mastered Objectives on Post-Test
1	8	64
2	28	88
3		72
4		84
5	16	64
6		88
7		84
8		44
9		80
10		64
11		76
12		56
13		76
14		68
15		56
16		32

Number tested 25
*Students did not take the pre-test for objectives 6-16.

Seven of the sixteen objectives (forty-four percent) were mastered by at least seventy-five percent of the students in grade

four. All of the objectives, with the exception of objectives 8 and 16 were mastered by at least fifty percent of the students. Objective 8 involved reading and identifying millilitre, litre, and kilolitre. Objective 16 involved identifying specific temperatures. After the post-test was administered, the teacher indicated she had not given instruction in this area.

The following increases were noted on objectives 1 through 5: 1, fifty-six percent; 2, sixty percent; 3, seventy-two percent; 4, eighty-four percent; and 5, forty-eight percent. Students did not take the pre-test for objectives 6 through 16, therefore, the increase could not be determined.

One factor which may have influenced the test results in the fourth grade was an interruption in the teaching of the unit. One of the members of the teacher's immediate family died while the unit was being taught and a substitute was temporarily employed.

Terminal objective 4 was not met by the fourth grade students.

TABLE 13

OBJECTIVES MASTERED BY FIFTH GRADE
STUDENTS ON METRIC PRE-TEST
AND POST-TEST
DECEMBER 1978 AND MARCH 1979

Objective	Percentage of Students Who Mastered Objectives on Pre-Test	Percentage of Students Who Mastered Objectives on Post-Test
1		40
2	20	92
3	12	72
4	60	92
5	4	32
6	60	100
7	44	88
8	68	100
9	56	84
10	24	56
11		44
12	4	88
13		64
14		52
15		36
16	24	92
17	36	96
18	4	72
19	8	60
20	20	80

Number tested 25

Ten of the twenty objectives (fifty percent) were mastered by at least seventy-five percent of the students in grade five. Six of the objectives were mastered by at least ninety percent of the students.

There was an increase in the percentage of students who mastered each objective on the post-test compared to the pre-test.

The most significant increases were noted on objectives 2, seventy-two percent; 3, sixty percent; 12, eighty-four percent; 13, sixty-four percent; 14, fifty-two percent; 16, sixty-eight percent; 17, sixty percent; 18, sixty-eight percent; 19, fifty-two percent; and 20, sixty percent.

Objectives 1, 5, 11, and 15 were mastered by at least fifty percent of the students. In order to master objectives 1, 11, and 15 the student had to write decimal equivalents for metric units. Decimal usage is difficult for fifth grade students in all areas of mathematics. Mastery of objective 5 required the student to have an understanding of the relationship of units in the metric system to units in the customary system. This is a concept which is acquired after extensive application of metric skills.

Although terminal objective 2 was not met by the fifth grade students, progress was made on all of the objectives.

In summary, terminal objective 2 was met by students in grades two and three. An analysis of the objectives which were not mastered by at least seventy-five percent of the students at all grade levels revealed that eight of the objectives were involved with length, ten with volume, four with mass, three with temperature, one with area, and one with the relationship of units.

VII. INSTITUTIONALIZING THE RESULTS

At the conclusion of the practicum student objectives, criteria for mastery, pre-tests, post-tests, instructional units, and reference materials were packaged in a metric handbook and were distributed to the principals in the five schools served by the writer. After reviewing the handbook and sharing it with the teachers in their schools, the principals informed the writer of the number of teachers who indicated they would like to teach the instructional units during the 1979-80 school year. The number of teachers, in the five schools, included ten first grade teachers, thirteen second grade teachers, thirteen third grade teachers, thirteen fourth grade teachers, and ten fifth grade teachers.

In March 1979 an order was placed for $225 for metric materials for the 1979-80 school year. Additional orders will be placed in July 1979, when the new fiscal year begins.

The writer met with the director of elementary education to discuss the probability of using the instructional units in the schools in the county served by other elementary supervisors. He recommended that copies of the metric handbook be given to the six elementary supervisors for use as a resource in establishing a metric education program in schools in their areas. A copy of the handbook was distributed to each supervisor.

In addition, a copy of the handbook was sent to the associate director of mathematics in the Stat Department of Education to be placed in the State Resource Library. Upon request, copies will be provided, by the writer, for teachers in other school systems.

VIII. CONCLUSION

A manageable metric education program for elementary students was developed as a result of this practicum. It is apparent from the test data that teachers and students benefited from the practicum experience. Throughout the implementation phase, teachers were responsive to suggestions, made recommendations, and demonstrated dedication to their assigned tasks.

One modification which should be made in the practicum design is to lengthen the in-service program for teachers. This would, in turn, increase the probability of teachers mastering the metric objectives. Further refinement of the practicum would include giving teachers the option of teaching the instructional units as an integral part of the curriculum throughout the school year, rather than for a scheduled period of time.

The instructional units, which have been developed, will serve as a base for the extension of metric awareness and skill development in the elementary schools in Henrico County. Educators, at all levels, must take the initiative for helping society reach the goal of "a metric America."

APPENDIXES

TEACHER'S SELF-INVENTORY

Code _____

Items	Rating				
	Excellent	Above Average	Average	Below Average	Poor
I would rate my skill in:					
1) Estimating with metric units as . .	1	2	3	4	5
2) Measuring with metric instruments as	1	2	3	4	5
3) Developing student activities for my classroom as	1	2	3	4	5
I would rate my knowledge of:					
4) The content and structure of the SI metric system as	1	2	3	4	5
5) Sources of curriculum materials as . .	1	2	3	4	5
6) Stages through which children's measurement skill and ability progress as	1	2	3	4	5

APPENDIX B

METRIC MEASUREMENT ATTITUDE SCALE

Instructions: Code_____

Circle one of the five possible responses located to the left of each statement. SA - strongly agree, A - agree, U - undecided, D - disagree, and SD - strongly disagree.

SA	A	U	D	SD	1. The school system should tool up immediately to teach metric measurement.
SA	A	U	D	SD	2. I ignore the metric part of dual labels when I am shopping.
SA	A	U	D	SD	3. The metric system of measurement is anti-American.
SA	A	U	D	SD	4. I will never understand the metric system.
SA	A	U	D	SD	5. Metric measurement is easier for me to understand than English measurement system.
SA	A	U	D	SD	6. Metric measurement confuses me.
SA	A	U	D	SD	7. I believe metric measurement is easier to use than the English system.
SA	A	U	D	SD	8. I convert from metric to English measurement instead of using metric.
SA	A	U	D	SD	9. I anticipate converting to metric measurement.
SA	A	U	D	SD	10. Metric measurement is exciting.
SA	A	U	D	SD	11. I believe the economic future of our country rests on our conversion to the metric system.
SA	A	U	D	SD	12. I look forward to the ease metric measurement will bring.
SA	A	U	D	SD	13. Thinking metric is no problem for me.
SA	A	U	D	SD	14. The metric system of measurement will destroy an important part of the American culture.

SA	A	U	D	SD	15.	When we switch to the metric system, I will continue to use English units of measurement.
SA	A	U	D	SD	16.	I am apprehensive about anything associated with metric measuement.
SA	A	U	D	SD	17.	I have already begun using some metric measurement.
SA	A	U	D	SD	18.	I believe the metric system is easy to learn.
SA	A	U	D	SD	19.	I expect learning metric measurement to be enjoyable.
SA	A	U	D	SD	20.	I am reluctant to change to the metric system.
SA	A	U	D	SD	21.	Only scientists and engineers need to know the metric system.
SA	A	U	D	SD	22.	Estimation is easier for me when I use metric units of measurement.

METRIC OBJECTIVES FOR TEACHERS

Communication Competencies

The teacher will:

1. Write the base unit for measuring length, mass, capacity, temperature, volume and area

2. Write the symbol for metre, kilometre, centimetre, millimetre, litre, gram, cubic centimetre, square metre, and degrees Celsius

3. Identify the meaning of the prefixes milli, centi, deci, deka, hecto, and kilo

Measurement Competencies

The teacher will:

4. Write an appropriate customary relationship for metre, kilogram, litre, and centimetre

5. Estimate length using millimetres, centimetres, metres, and kilometres

6. Estimate mass using grams, kilograms, and milligrams

7. Estimate volume using litres, kilolitres, and millilitres

Problem Solving Competencies

The teacher will:

8. Use the decimal system of numeration to change metric units

9. Solve problems involving metric units of length, mass, volume, and capacity

Consumer Competencies

The teacher will:

10. Identify the freezing and boiling points of water, room temperature, and body temperature

11. Identify the legal speed for driving an automobile in the city

12. Determine the appropriate metric unit for buying goods, selling goods, or for measuring.

METRIC TEST FOR TEACHERS

Code _____

1. Fill in the blanks.

   a. The _____ is the basic unit for measuring length in the metric system.

   b. The _____ is the basic unit for measuring mass in the metric system.

   c. The _____ is the basic unit for measuring capacity in the metric system.

   d. _____ is used to measure temperature in the metric system.

   e. To measure volume the answer would be expressed in _____ metres or _____ centimetres.

   f. To measure area the answer would be expressed in _____ metres or _____ centimetres.

2. Write the symbol for:

   a. metre _____

   b. kilometre _____

   c. centimetre _____

   d. millimetre _____

   e. litre _____

   f. gram _____

   g. Celsius _____

   h. cubic centimetre _____

   i. square metre _____

3. Match the prefix with the most appropriate meaning.

_____ a. centi	1. one-tenth
_____ b. kilo	2. one-hundredth
_____ c. deka	3. one-thousandth
_____ d. hecto	4. ten
_____ e. milli	5. hundred
_____ f. deci	6. thousand

4. List an approximate customary system relationship for each of the following:

a. A metre is _____.

b. A kilogram is _____.

c. A litre is _____.

d. A centimetre is _____.

5. Linear Matching

_____ a. two-month-old baby	1. 5 mm
_____ b. first-grade student	2. 25 mm
_____ c. center on pro basketball team	3. 55 cm
_____ d. college coed	4. 2 km
_____ e. football field length	5. 10 m
	6. 160 cm
	7. 500 cm
	8. 1 m
	9. 210 cm
	10. 91 m

6. Mass Matching

_____ a.	two-month-old baby	1. 1000 kg
_____ b.	pro football player	2. 1 kg
_____ c.	high school girl	3. 250 kg
_____ d.	first grade student	4. 27 mg
_____ e.	car	5. 4.5 kg
		6. 450 mg
		7. 23 kg
		8. 110 kg
		9. 50 000 g
		10. 500 kg

7. Volume Matching

_____ a.	bleach bottle	1. .5 ℓ
_____ b.	can of soup	2. 100 ml
_____ c.	aspirin tablet	3. 4 ℓ
_____ d.	tank of gasoline	4. 2 kl
_____ e.	thimbleful of water	5. 4 ml
		6. .1 ml
		7. 250 kl
		8. 40 kl
		9. 60 ℓ
		10. 250 ml

8. Complete the following:

   a. 1.6 m = _____ km = _____ cm

   b. 0.4 cm = _____ m = _____ mm

   c. 260 g = _____ kg

   d. 22.4 = _____ ml

   e. 2.2 kg = _____ g = _____ mg

9. Circle the best answer for each question.

   a. Joe plans to pave his driveway with 10 cm of concrete. If concrete costs $25 per cubic metre and the driveway is 4 metres by 30 metres, how much will the concrete cost?

      1. $ 50
      2. $ 300
      3. $ 500
      4. $1000

   b. A container of water measures .05 m by 40 mm by 1 dm. You probably would

      1. wash your car with it.
      2. drink it.
      3. take a bubble bath in it.
      4. water ski in it.

   c. Paper clips come 100 to a box. The net weight of one box is

      1. 10 g
      2. 1 kg
      3. 100 kg
      4. 100 g

d. How many average hamburger patties can you make from one kilogram of hamburger?

1. 1
2. 3
3. 10
4. 100

e. The weight of 3.852 litres of cold water is about

1. 3852 g
2. 3852 kg
3. 38.52 kg
4. 3.852 ml

f. How many persons could be served with 10 litres of punch if average consumption is 200 cubic centimetres?

1. 2 people
2. 10 people
3. 50 people
4. 100 people

10. Match the event with the most appropriate temperature.

_____ a.	water freezes	1. 100 °C
_____ b.	a comfortable room	2. 37 °C
_____ c.	water boils	3. 0 °C
_____ d.	a cake bakes	4. 21 °C
_____ e.	normal body temperature	5. 160 °C

11. A typical speed limit for city driving (in kilometres per hour) is

    a. 45

    b. 200

    c. 75

    d. 20

12. Write in the unit you would use to measure the following:

    a. container of milk _____

    b. a beef roast _____

    c. a length of rope _____

    d. a box of cereal _____

    e. a zipper _____

    f. a lawn _____

    g. a room temperature _____

    h. electricity used _____

METRIC TEST FOR TEACHERS ANSWERS

1. a. metre
   b. kilogram
   c. litre
   d. Degrees Celsius
   e. cubic, cubic
   f. square, square

2. a. m
   b. km
   c. cm
   d. mm
   e. ℓ
   f. g
   g. °C
   h. cm^3
   i. m^2

3. a. 2
   b. 6
   c. 4
   d. 5
   e. 3
   f. 1

4. a. a little more than a yard
   b. a little more than two pounds
   c. a little more than a quart
   d. a little less than one-half inch

5. a. 3
   b. 8
   c. 9
   d. 6
   e. 10

6. a. 5
   b. 8
   c. 9
   d. 7
   e. 1

7. a. 1
   b. 10
   c. 6
   d. 9
   e. 5

8. a. 0.0016, 160
   b. 0.4, 4
   c. 0.26
   d. 22 400
   e. 2200, 2200 000

9. a. 2
   b. 2
   c. 4
   d. 3
   e. 1
   f. 3

10. a. 3
    b. 4
    c. 1
    d. 5
    e. 2

11. (a)

12. a. litre
    b. kilogram
    c. metre
    d. gram
    e. centimetre
    f. square metre
    g. degrees Celsius
    h. kilowatt

MASTERY LEVEL FOR TEACHER OBJECTIVES

Objective	Number of Items	Mastery Level
1	8	6
2	9	7
3	6	5
4	4	3
5	5	4
6	5	4
7	5	4
8	8	6
9	6	5
10	5	4
11	1	1
12	8	6

METRIC RELATED STATE OBJECTIVES - BASIC LEARNING SKILLS

Grade 1

12.18 The student will recognize a ruler as an instrument for measuring length.

12.25 The student will recognize scales as an instrument for measuring mass.

Grade 2

12.19 The student will use a ruler marked in centimetres to measure a line segment to the nearest unit.

12.29 The student will read temperature shown on a Celsius thermometer.

12.30 The student will recognize the litre as a measurement for liquid.

Grade 3

12.20 The student will select the appropriate instrument to measure the length of a given object.

12.26 The student will read a scale to determine the mass of objects to the nearest kilogram.

12.31 The student will recognize the litre as a measurement for liquid.

Grade 4

12.21 The student will find the perimeter of a rectangle, given the measurements of each side.

Grade 5

(None)

METRIC OBJECTIVES

Grade 1

The student will:

1. Recognize a centimetre ruler and a metre stick as instruments for measuring length.
2. Compare the relative lengths of given objects.
3. Find the length of objects using arbitrary units.
4. Measure the length of objects in centimetres.
5. Recognize a litre container as an instrument for measuring liquids.
6. Recognize scales as an instrument for measuring mass (weight).
7. Recognize a thermometer as an instrument for measuring temperature.

METRIC OBJECTIVES

Grade 2

The student will:

1. Read and identify the words centimetre and metre.
2. Write the symbols for the words centimetre and metre.
3. Compare the relative lengths of given objects.
4. Measure the length of a pictorial representation in centimetres.
5. Read and identify the word litre.
6. Write the symbol for the word litre.
7. Read and identify words gram and kilogram.
8. Write the symbols for the words gram and kilogram.
9. Read the temperature on a Celsius thermometer.

METRIC OBJECTIVES

Grade 3

The student will:

1. Read and identify the words centimetre, metre, and kilometre.
2. Write the symbols for the words centimetre, metre, and kilometre.
3. Measure line segments to the nearest centimetre.
4. Draw line segments to the nearest centimetre.
5. Convert from centimetre to metre and metre to kilometre.
6. Find the perimeter of a rectangle.
7. Read and identify the words millilitre and litre.
8. Write the symbols for the words millilitre and litre.
9. Compare litres and millilitres.
10. Read and identify the words gram and kilogram.
11. Write the symbols for the words gram and kilogram.
12. Read the temperature on a Celsius thermometer.
13. Identify the freezing and boiling points of water on a Celsius thermometer.

METRIC OBJECTIVES

Grade 4

The student will:

1. Read and identify the words millimetre, metre, centimetre, decimetre, kilometre, hectometre, and dekametre.
2. Write the symbols for the words millimetre, centimetre, decimetre, metre, kilometre, hectometre, and dekametre.
3. Convert from millimetre to centimetre, centimetre to metre, decimetre to metre, and metre to kilometre.
4. Estimate the length of a line segment to the nearest centimetre.
5. Compare the relative lengths of metric linear units.
6. Find the perimeter of a polygon.
7. Find the area of a rectangle by counting the number of square units inside the rectangle.
8. Read and identify the words millilitre, litre, and kilolitre.
9. Write the symbols for the words millilitre, litre, and kilolitre.
10. Convert from kilolitre to litre to millilitre.
11. Find the volume of a figure by counting cubic units.
12. Read and identify the words gram and kilogram.
13. Write the symbols for the words gram and kilogram.
14. Convert from kilogram to gram.
15. Read the temperature on a Celsius thermometer.
16. Identify the freezing and boiling points of water, room temperature, and body temperature on a Celsius thermometer.

METRIC OBJECTIVES

Grade 5

The student will:

1. Read and identify the words millimetre, metre, centimetre, decimetre, kilometre, hectometre, and dekametre.
2. Write the symbols for the words millimetre, metre, centimetre, decimetre, kilometre, hectometre, and dekametre.
3. Convert from millimetre to centimetre, centimetre to metre, decimetre to metre, and metre to kilometre.
4. Estimate the length of a line segment to the nearest centimetre.
5. Recognize the relationship between metres and yards, centimetres and inches, and kilometres and miles.
6. Find the perimeter of a polygon.
7. Construct a triangle or rectangle of given dimensions.
8. Find the area of a rectangle by counting the number of square units inside the rectangle.
9. Find the area of a rectangle by multiplying length and width.
10. Find the missing dimension of a rectangle when presented with the area and one dimension.
11. Read and identify the words millilitre, litre, and kilolitre.
12. Write the symbols for the words millimetre, litre, kilolitre, and cubic metre.
13. Convert from kilolitre to litre to millilitre.
14. Calculate volume by multiplying length times width times height.
15. Read and identify the words milligram, gram, and kilogram.

16. Write the symbols for the words milligram, gram, and kilogram.

17. Determine when to use gram and kilogram in everyday situations.

18. Convert from kilogram to gram to milligram.

19. Read the temperature on a Celsius thermometer.

20. Make judgments based upon facts about temperature in Celsius units.

ORAL DIRECTIONS FOR METRIC PRE-TEST AND POST-TEST

Grade 1

Oral Directions:

1. Look at the instruments. Which one would you use to measure the length of something in centimetres? (A centimetre ruler, litre container, and metric scales should be shown to the student .)

   Which one would you use to measure the length of something in metres? (A metre stick, litre container, and metric scales should be shown to the student.)

2. Look at the pictures in the three boxes at the top of the page. Draw a circle around the longer object in each box.

   Look at the pictures in the three boxes at the bottom of the page. Draw a circle around the shorter object in each box.

3. Look at the line beside number 1. The line is one finger long. A 1 is written in the box. Look at number 2. Use your finger to measure the length of the line. Write the answer in the box. Do the rest of the page by yourself. Write the answers in the boxes.

4. Use your centimetre ruler to measure the length of the objects on the page. Write your answer on the line beside the picture.

5. Look at the instruments. Which one would you use to measure how much something could hold in litres? (A centimetre ruler, litre container, and metric scales should be shown to the student.)

6. Look at the instruments. Which one would you use to measure how heavy something is in kilograms? (A centimetre ruler, litre container, and metric scales should be shown to the student.)

7. Look at the thermometers. Write on the line under each thermometer the temperature which is shown on the thermometer.

METRIC TEST

Answer Sheet
Grade 1

_____ Date

_____ Name

1. Centimetre ruler _____ yes _____ no

   Metre stick _____ yes _____ no

2. Number correct _____

3. Number correct _____

4. Number correct _____

5. Litre _____ yes _____ no

6. Scales _____ yes _____ no

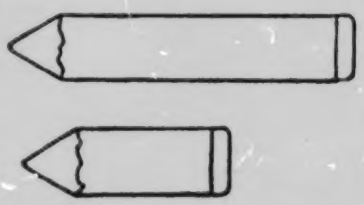
7. Thermometer _____ yes _____ no

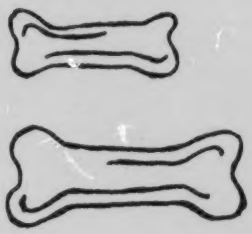
METRIC PRE-TEST

Grade 1

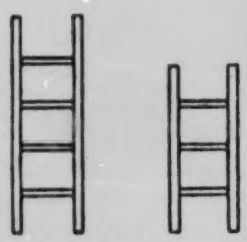
Date _____ Name _____

Which is longer?





Which is shorter?



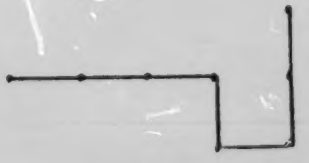
1.

2.

3.

4.

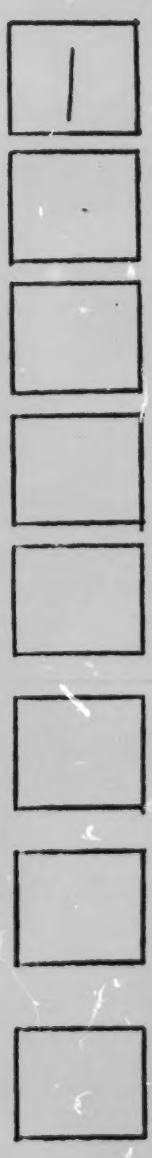
5.



6.

7.

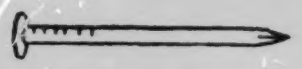
8.



4.

92

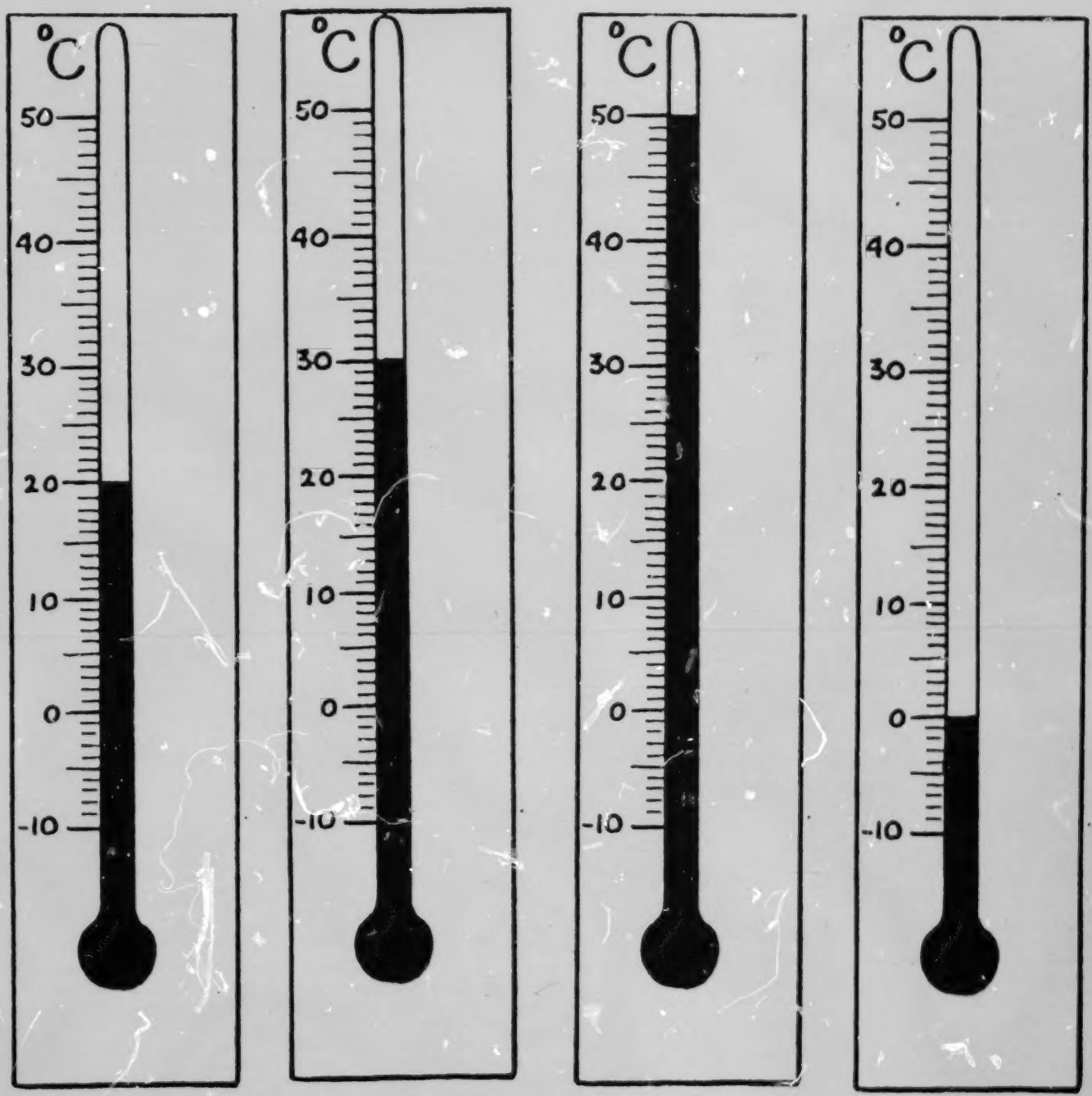
____ cm



____ cm

____ cm

____ cm



_____ C

_____ C

_____ C

_____ C

METRIC PRE-TEST ANSWERS

Grade 1

1. Teacher judgment

2. Teacher judgment

3. 4
   2
   7
   7
   5
   10
   13

4. 16
   4
   9
   12

5. Teacher judgment

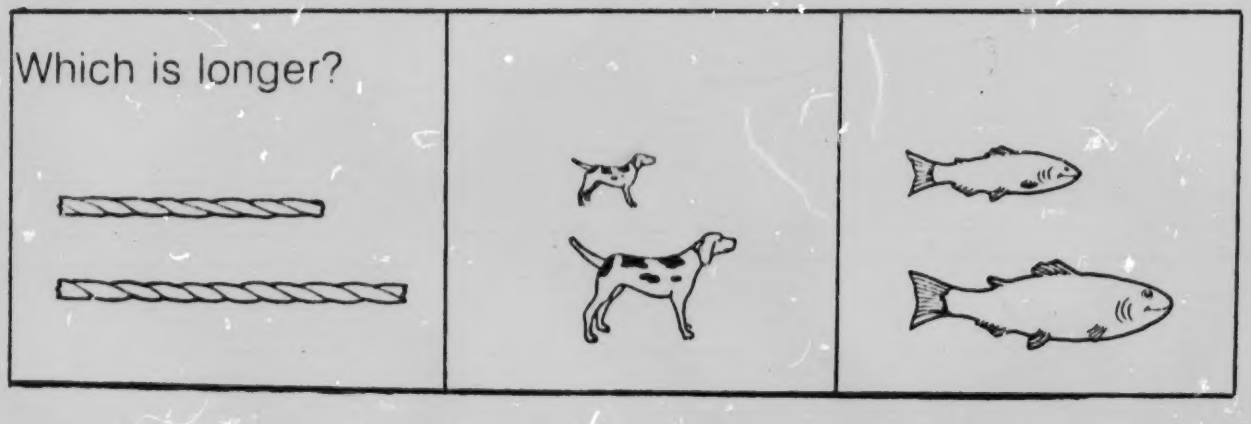
6. Teacher judgment

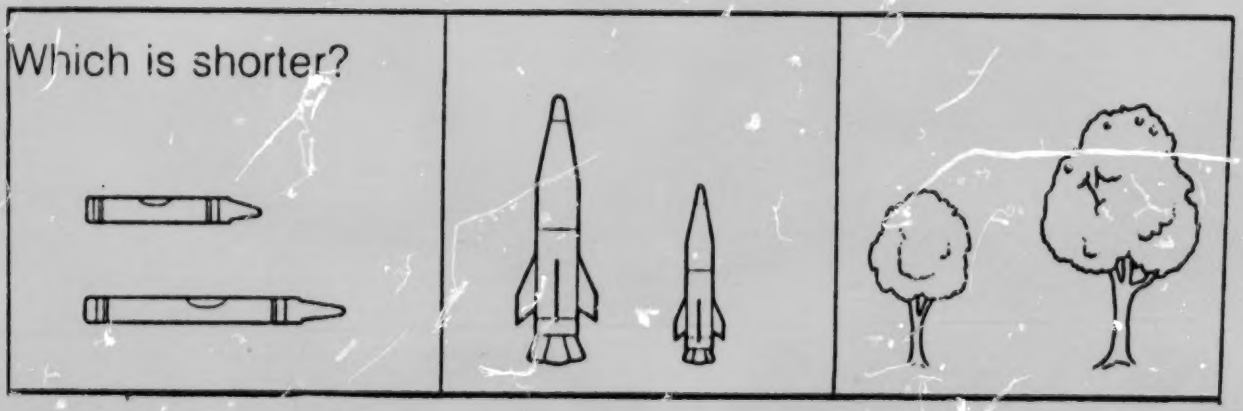
7. 20°
   30°
   50°
   0°

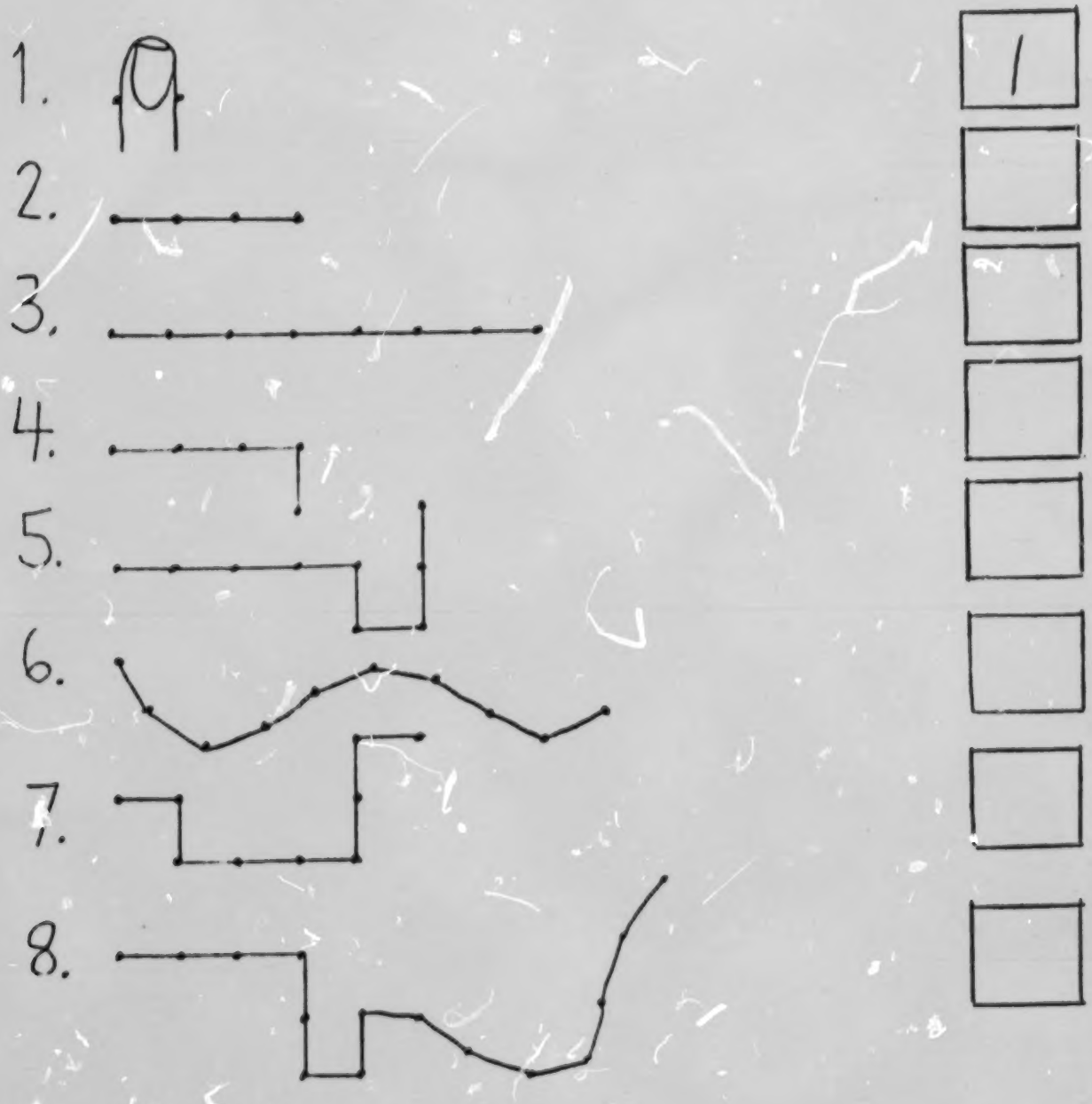
METRIC POST-TEST

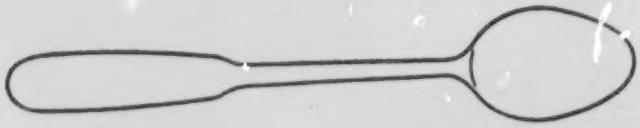
Grade 1

Date _____ Name _____


Which is longer?

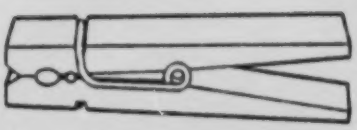

Which is shorter?


1.
2.
3.
4.
5.
6.
7.
8.
1

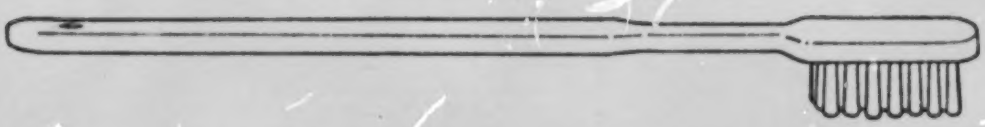


___ cm

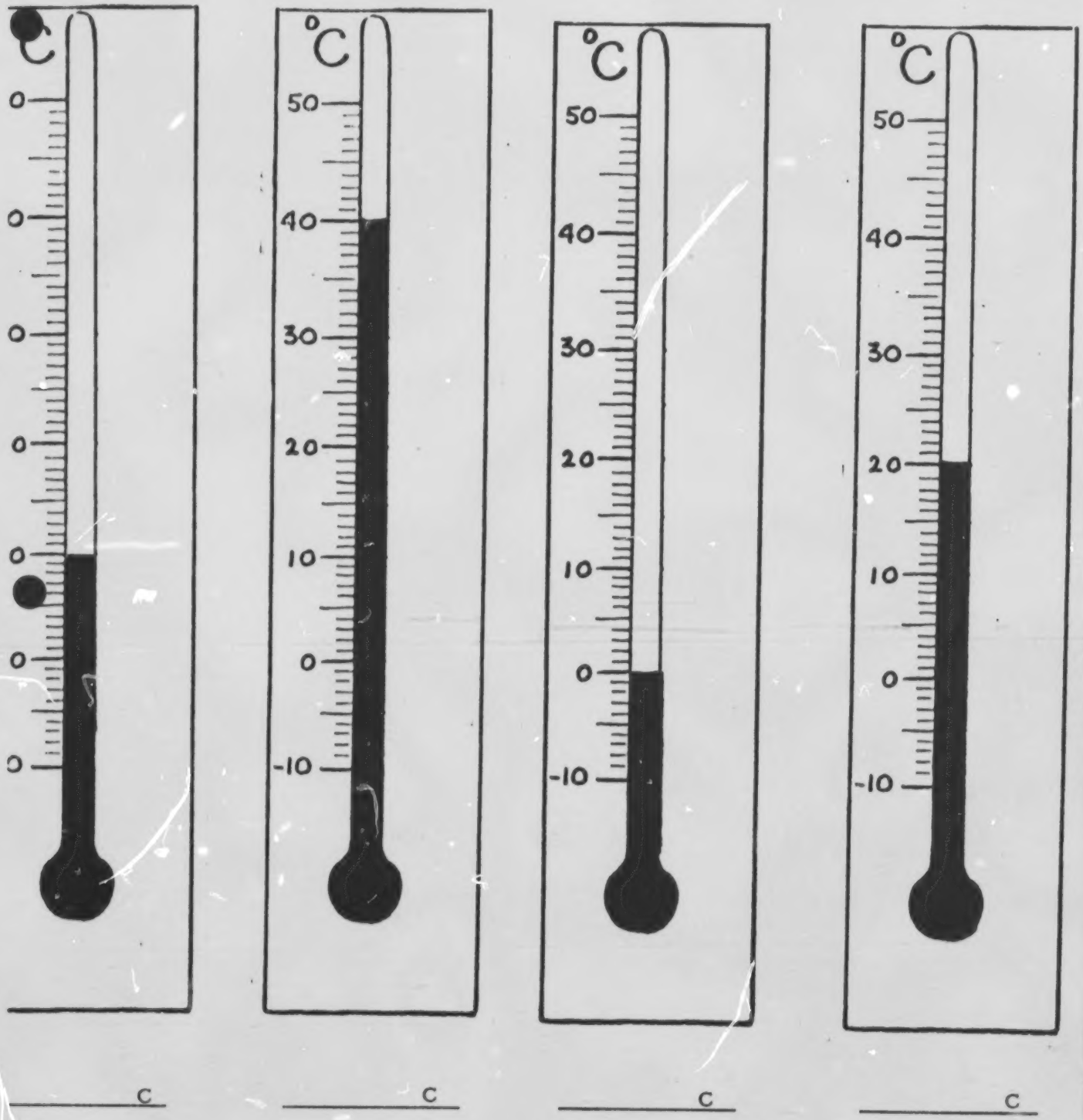
___ cm



___ cm



___ cm


°C
0
0
0
0
0
0
°C
50
40
30
20
10
0
-10
°C
50
40
30
20
10
0
-10
°C
50
40
30
20
10
0
-10
C
C
C
C

METRIC POST-TEST ANSWERS

Grade 1

1. Teacher judgment

2. Teacher judgment

3. 3
   7
   4
   8
   9
   8
   14

4. 9
   15
   5
   14

5. Teacher judgment

6. Teacher judgment

7. 10°
   40°
   0°
   20°

ORAL DIRECTIONS FOR METRIC PRE-TEST

Grade 2

1. Look at the four words beside number 1. Draw a circle around the word metre.

2. Look at number 2. You will see the letters a, b, c, and d. Draw a circle around the correct answer after I read the choices to you. A metre is used to:

   a. measure how hot something is.

   b. measure how much something can hold.

   c. measure how heavy something is.

   d. measure how long something is.

   Now circle the answers.

3. Look at the four words beside the number 3. Draw a circle around the word centimetre.

4. Look at number 4. Draw a circle around the correct answer after I read the choices to you. A centimetre is:

   a. longer than this room.

   b. shorter than a metre.

   c. the same length as a metre.

   d. longer than a metre.

   Now circle the answer.

5. Look at number 5. Write on the line beside number 5 a short way to write metre.

6. Look at number 6. Write on the line beside number 6 a short way to write centimetre.

7. Look at number 7. You will see some objects in boxes. Draw a circle around the longest object in each box.

8. Look at number 8. You will see some objects in boxes. Draw a circle around the shortest object in each box.

9. Look at number 9. You will see some objects. Use your ruler to measure the length of each object in centimetres. Write the answer on the line beside the object.

10. Look at the four words beside the number 10. Draw a circle around the word litre.

11. Look at number 11. Draw a circle around the correct answer after I read the choices to you. A litre is used to:

    a. measure how hot something is.

    b. measure how much something can hold.

    c. measure how long something is.

    d. measure how heavy something is.

    Now circle the answer.

12. Look at number 12. Write on the line beside number 12 a short way to write litre.

13. Look at the four words beside the number 13. Draw a circle around the word gram.

14. Look at number 14. Draw a circle around the correct answer after I read the choices to you. A gram is used to:

    a. measure how long something is.

    b. measure how hot something is.

    c. measure how much something can hold.

    d. measure how heavy something is.

    Now circle the answer.

15. Look at the four words beside the number 15. Draw a circle around the word kilogram.

16. Look at number 16. Draw a circle around the correct answer after I read the choices to you. A kilogram is:

    a. as light as a feather.

    b. the same as a gram.

    c. less than a gram.

    d. more than a gram.

    Now circle the answer.

17. Look at number 17. Write on the line beside number 17 a short way to write the word gram.

18. Look at number 18. Write on the line beside number 18 a short way to write the word kilogram.

19. Look at the four thermometers. Write on the line under each thermometer the temperature it shows.

METRIC PRE-TEST

Grade 2

_____ Date

_____ Name

1. merry music must metre

2. A metre is used to:

   a. measure how hot something is.

   b. measure how much something can hold.

   c. measure how heavy something is.

   d. measure how long something is.

3. central centimetre certain column

4. A centimetre is:

   a. longer than this room.

   b. shorter than a metre.

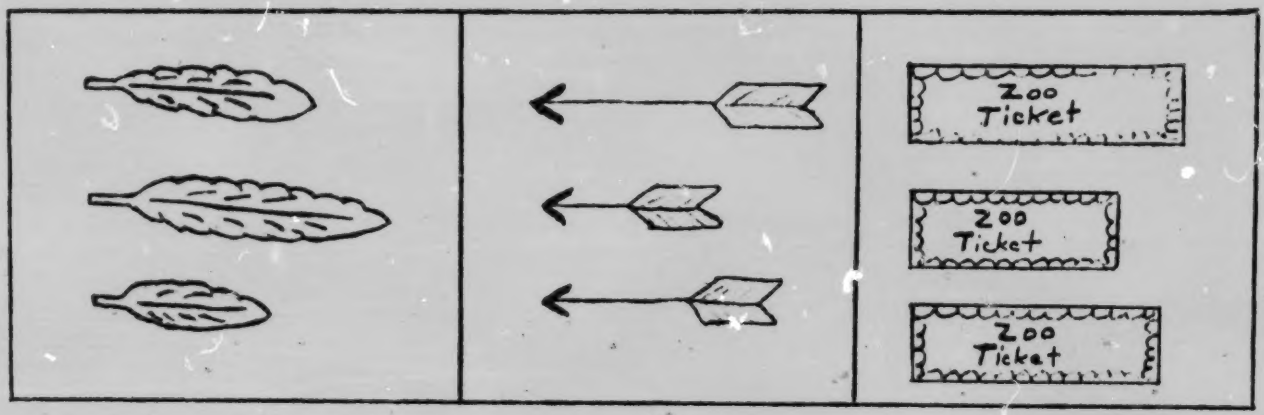
   c. the same length as a metre.

   d. longer than a metre.

5. _____

6. _____

7.



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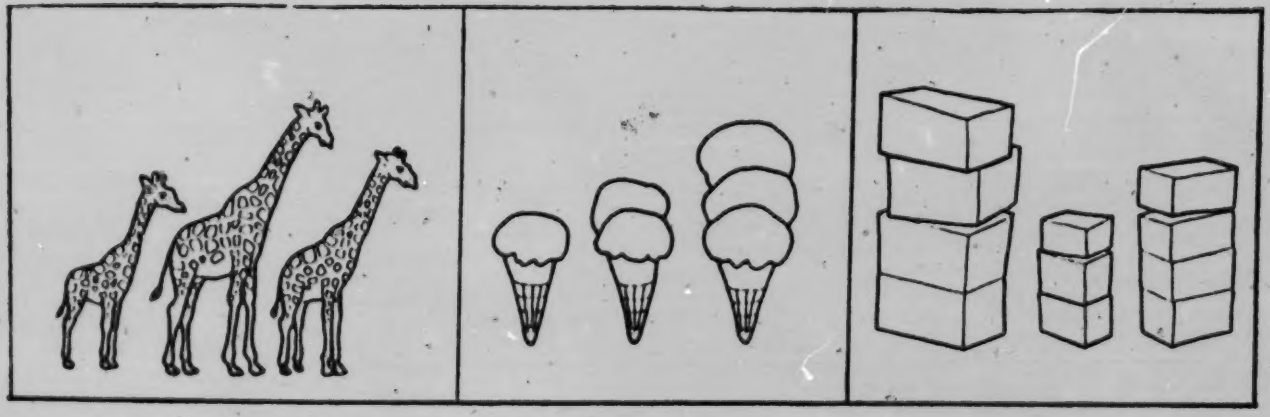
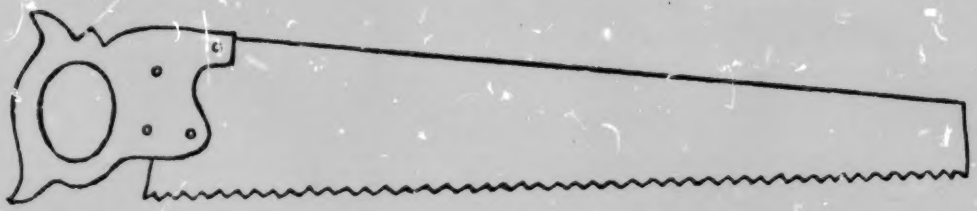


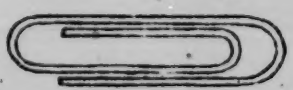
9.

a. 

_____ cm

b.

_____ cm

c. 

_____ cm

d.

_____ cm

10. litre likely length lunch

11. A litre is used to:

    a. measure how hot something is.

    b. measure how much something can hold.

    c. measure how long something is.

    d. measure how heavy something is.

12. _____

13. grade grab great gram

14. A gram is used to:

    a. measure how long something is.

    b. measure how hot something is.

    c. measure how much something can hold.

    d. measure how heavy something is.

15. kilogram kind killing kerchief

16. A kilogram:

    a. as light as a feather.

    b. the same as a gram.

    c. less than a gram.

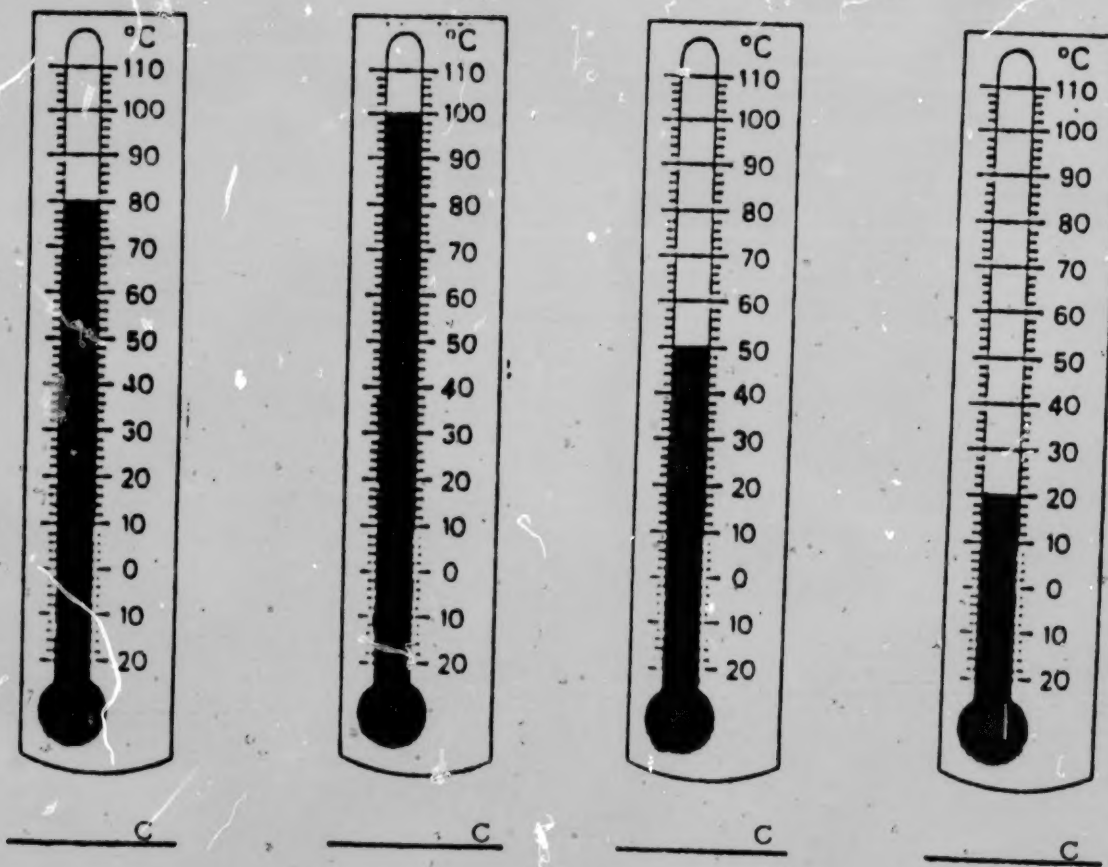
    d. more than a gram.

17. _____

18. _____

19.

108



METRIC PRE-TEST ANSWERS

Grade 2

1. metre
2. (d)
3. centimetre
4. (b)
5. m
6. cm
7. Teacher judgment
8. Teacher judgment
9. 14
   16
   4
   11
10. litre
11. (b)
12. ℓ
13. gram
14. (d)
15. kilogram
16. (d)
17. g
18. kg
19. a. 80°
    b. 100°
    c. 50°
    d. 20°

ORAL DIRECTIONS FOR METRIC POST-TEST

Grade 2

1. Look at the four words beside number 1. Draw a circle around the word metre.

2. Look at number 2. You will see the letters a, b, c, and d. Draw a circle around the correct answer after I read the choices to you. A metre is used to:

   a. measure how long something is.

   b. measure how heavy something is.

   c. measure how much something can hold.

   d. measure how hot something is.

   Now circle the answer.

3. Look at the four words beside the number 3. Draw a circle around the word centimetre.

4. Look at number 4. Draw a circle around the correct answer after I read the choices to you. A centimetre is:

   a. longer than a metre.

   b. the same length as a metre.

   c. shorter than a metre.

   d. longer than this room.

   Now circle the answer.

5. Look at number 5. Write on the line beside number 5 a short way to write metre.

6. Look at number 6. Write on the line beside number 6 a short way to write centimetre.

7. Look at number 7. You will see some objects in boxes. Draw a circle around the longest object in each box.

8. Look at number 8. You will see some objects in boxes. Draw a circle around the shortest object in each box.

9. Look at number 9. You will see some objects. Use your ruler to measure the length of each object in centimetres. Write the answer on the line beside the object.

10. Look at the four words beside the number 10. Draw a circle around the word litre.

11. Look at number 11. Draw a circle around the correct answer after I read the choices to you. A litre is used to:

    a. measure how heavy something is.

    b. measure how long something is.

    c. measure how much something can hold.

    d. measure how hot something is.

    Now circle the answer.

12. Look at number 12. Write on the line beside number 12 a short way to write litre.

13. Look at the four words beside the number 13. Draw a circle around the word gram.

14. Look at number 14. Draw a circle around the correct answer after I read the choices to you. A gram is used to:

    a. measure how heavy something is.

    b. measure how much something can hold.

    c. measure how hot something is.

    d. measure how long something is.

15. Look at the four words beside the number 15. Draw a circle around the word kilogram.

16. Look at number 16. Draw a circle around the correct answer after I read the choices to you. A kilogram is:

    a. more than a gram.

    b. less than a gram.

    c. the same as a gram.

    d. as light as a feather.

17. Look at number 17. Write on the line beside number 17 a short way to write the word gram.

18. Look at number 18. Write on the line beside number 18 a short way to write the word kilogram.

19. Look at the four thermometers. Write on the line under each thermometer the temperature it shows.

METRIC POST-TEST

Grade 2

Date _____ Name _____

1. mother made metre man

2. A metre is used to:

   a. measure how long something is.

   b. measure how heavy something is.

   c. measure how much something can hold.

   d. measure how hot something is.

3. centimetre century country calendar

4. A centimetre is:

   a. longer than a metre.

   b. the same length as a metre.

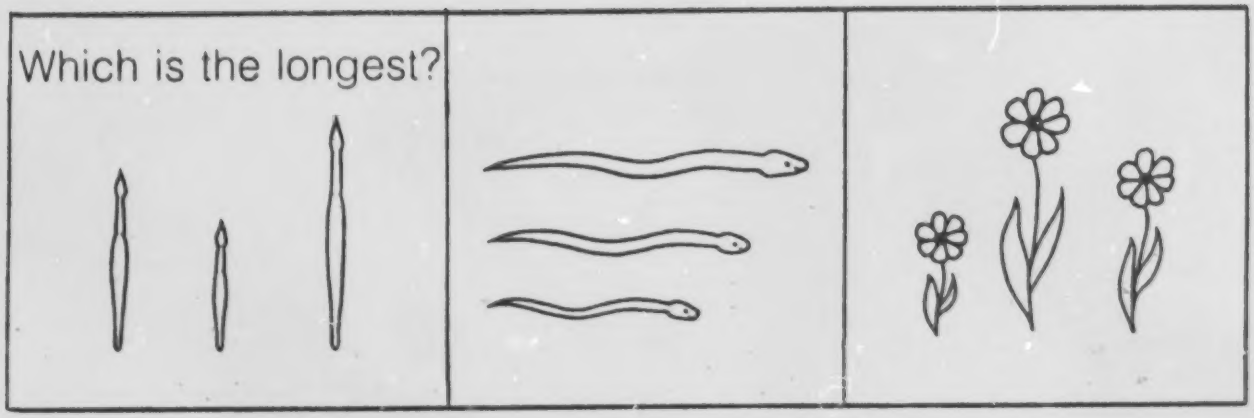
   c. shorter than a metre.

   d. longer than this room.

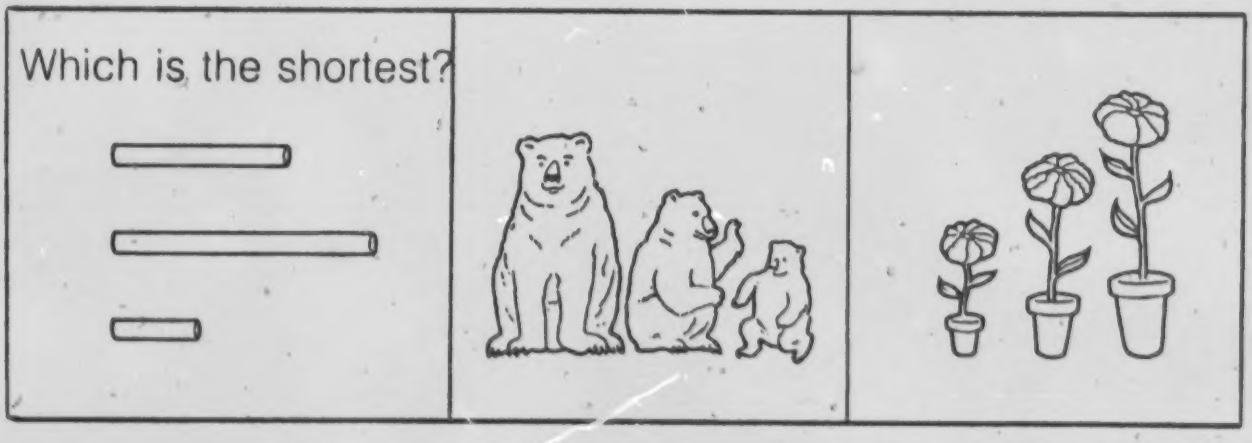
5. _____

6. _____

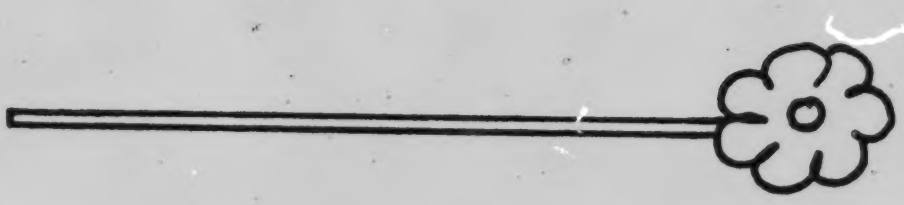
7.



8.

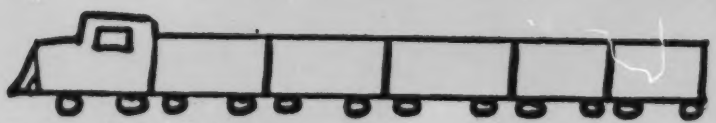


2.

a.  _____ cm

b. _____ cm

c. _____ cm

d.  _____ cm

10. letter litre little light

11. A litre is used to:

    a. measure how heavy something is.

    b. measure how long something is.

    c. measure how much something can hold.

    d. measure how hot something is.

12. _____

13. give green grow gram

14. A gram is used to:

    a. measure how heavy something is.

    b. measure how much something can hold.

    c. measure how hot something is.

    d. measure how long something is.

15. keep kilogram knife king

16. A kilogram is:

    a. more than a gram.

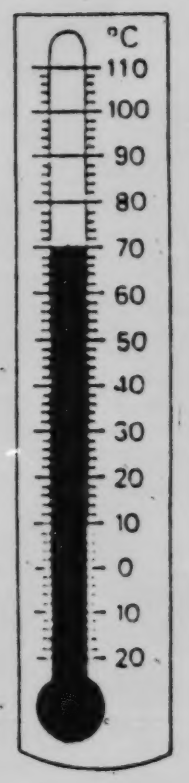
    b. less than a gram.

    c. the same as a gram.

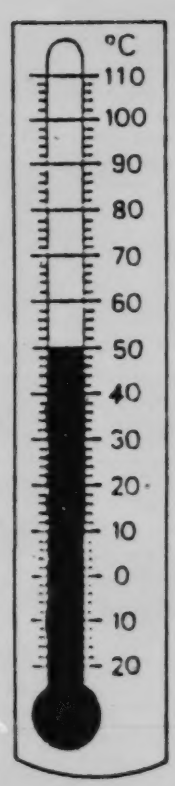
    d. as light as a feather.

17. _____

18. _____


°C
110
100
90
80
70
60
50
40
30
20
10
0
10
20

C


°C
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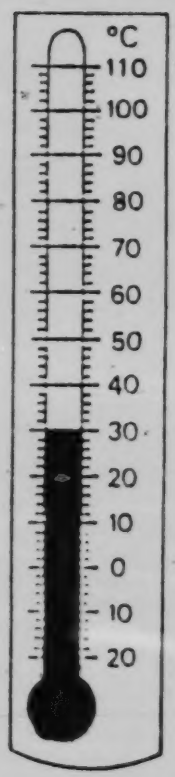
C


°C
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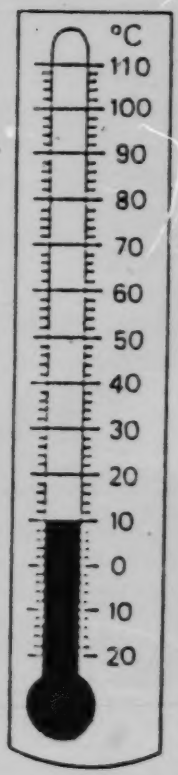
20

C


°C
110
100
90
80
70
60
50
40
30
20
10
0
10
20

C

METRIC POST-TEST ANSWERS

Grade 2

1. metre
2. (a)
3. centimetre
4. (c)
5. m
6. cm
7. Teacher judgment
8. Teacher judgment
9. a. 13
   b. 5
   c. 8
   d. 10
10. litre
11. (c)
12. ℓ
13. gram
14. (a)
15. kilogram
16. (a)
17. g
18. kg
19. a. 70°
    b. 50°
    c. 30°
    d. 10°

METRIC PRE-TEST

Grade 3

Date _____ Name _____

1. Complete the following.

   a. 1 kilometre = _____ metre(s)

   b. 1 metre = _____ metre(s)

   c. 1 metre = _____ centimetre(s)

2. Write the symbol for the metric units.

   a. kilometre = _____

   b. centimetre = _____

   c. metre = _____

3. Write the length of each line segment.

   a. _____ _____ cm

   b. _____ _____ cm

   c. _____ _____ cm

   d. _____ _____ cm

4. Draw the following line segments.

   a. 7 cm

   b. 5 cm

   c. 2 cm

   d. 9 cm

5. Complete the following.

   a. 300 cm = _____ m

   b. 5 m = _____ cm

   c. 400 cm = _____ m

   d. 2 m = _____ cm

   e. 6000 m = _____ km

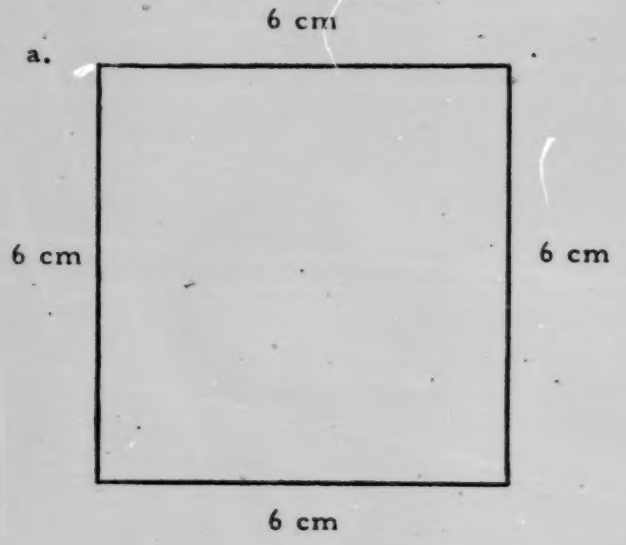
   f. 5000 m = _____ km

   g. 3 km = _____ m

   h. 2 km = _____ m

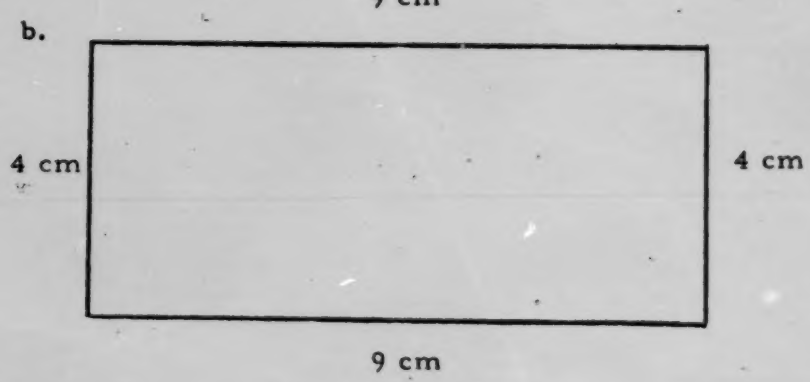
6. Find the perimeter of the figures.

a.



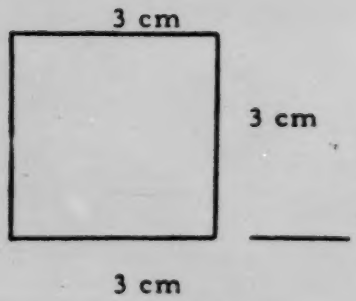
_____ cm

b.



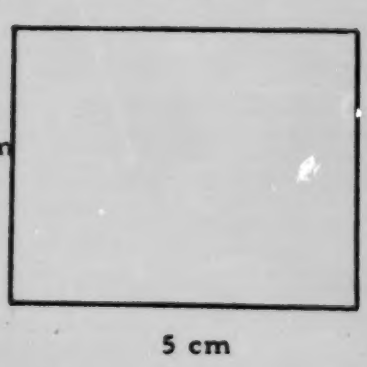
_____ cm

c.



_____ cm

d.



_____ cm

7. Complete the following.

   a. 1 litre = _____ litre(s)

   b. 1 litre = _____ millilitre(s)

8. Write the symbol for the metric units.

   a. millilitre = _____

   b. litre = _____

9. Circle which container would hold the most.

   a. 4 ℓ or 500 ml

   b. 3000 ml or 1 ℓ

   c. 5 ℓ or 6000 ml

   d. 700 ml or 2 ℓ

10. Complete the following.

   a. 1 gram = _____ gram(s)

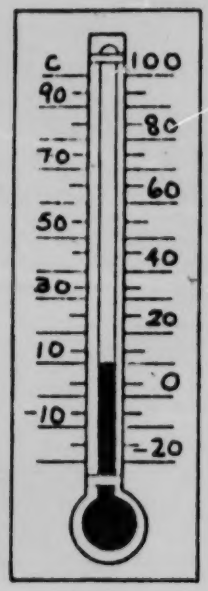
   b. 1 kilogram = _____ gram(s)

11. Write the symbol for the metric units.

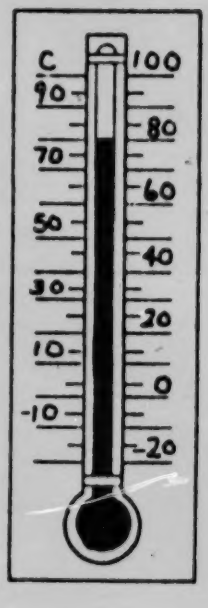
   a. kilogram = _____

   b. gram = _____

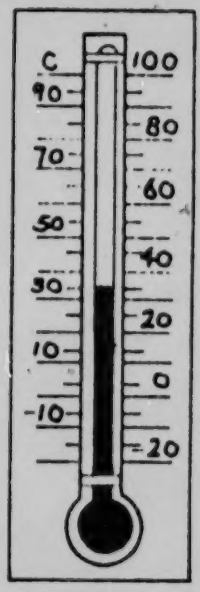
12. Write the temperature shown on each thermometer.

a. 

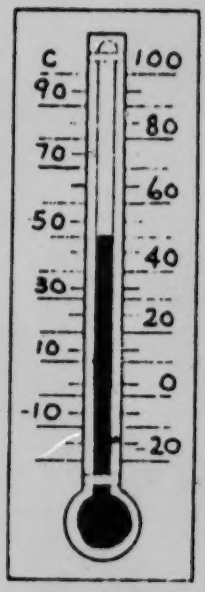
_____ C

b. 

_____ C

c. 

_____ C

d. 

_____ C

13. Complete the following.

a. The freezing point of water is _____ °C.

b. The boiling point of water is _____ °C.

METRIC PRE-TEST ANSWERS

Grade 3

1. a. 1000
   b. 1
   c. 100

2. a. km
   b. cm
   c. m

3. a. 7
   b. 4
   c. 10
   d. 8

4. a. Teacher judgment
   b. Teacher judgment
   c. Teacher judgment
   d. Teacher judgment

5. a. 3
   b. 500
   c. 4
   d. 200
   e. 6
   f. 5
   g. 3000
   h. 2000

6. a. 24
   b. 26
   c. 12
   d. 18

7. a. 1
   b. 1000

8. a. ml
   b. ℓ

9. a. 4 ℓ
   b. 3000 ml
   c. 6000 ml
   d. 2 ℓ

10. a. 1
    b. 1000

11. a. kg
    b. g

12. a. 10°
    b. 80°
    c. 35°
    d. 50°

13. a. 0
    b. 100

METRIC POST-TEST

Grade 3

_____ Date

_____ Name

1. Complete the following.

   a. 1 metre = _____ centimetre(s)

   b. 1 metre = _____ metre(s)

   c. 1 kilometre = _____ metre(s)

2. Write the symbol for the metric units.

   a. metre = _____

   b. centimetre = _____

   c. kilometre = _____

3. Write the length of each line segment.

   a. _____ _____ cm

   b. _____ _____ cm

   c. _____ _____ cm

   d. _____ _____ cm

4. Draw the following line segments.

a. 4 cm

b. 8 cm

c. 1 cm

d. 10 cm

5. Complete the following.

a. 200 cm = _____ m

b. 6 m = _____ cm

c. 300 cm = _____ m

d. 5 m = _____ cm

e. 7000 m = _____ km

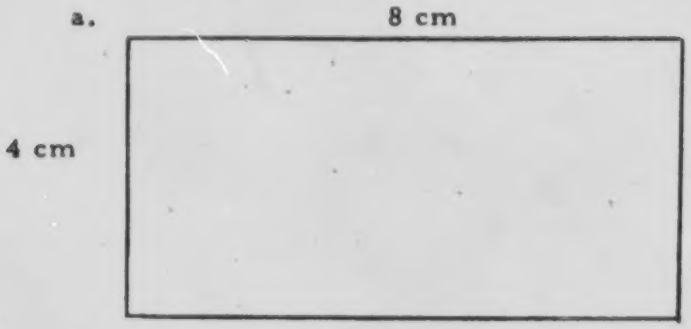
f. 2000 m = _____ km

g. 4 km = _____ m

h. 2 km = _____ m

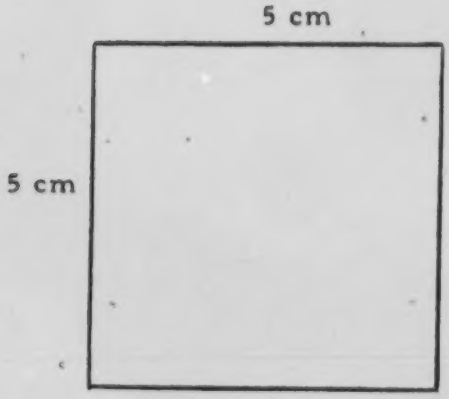
6. Find the perimeter of the figures.

a.



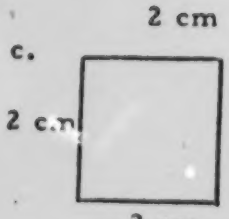
____ cm

b.



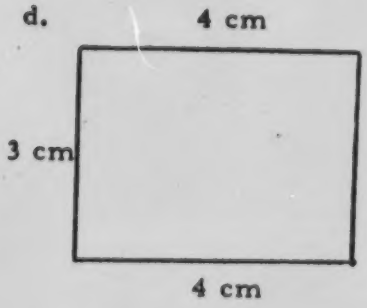
____ cm

c.



____ cm

d.



____ cm

7. Complete the following.

   a. 1 litre = _____ millilitre(s)

   b. 1 litre = _____ litre(s)

8. Write the symbol for the metric units.

   a. litre = _____

   b. millilitre = _____

9. Circle which container would hold the most.

   a. 5 ℓ or 600 ml

   b. 2000 ml or 1 ℓ

   c. 3 ℓ or 4000 ml

   d. 900 ml or 2 ℓ

10. Complete the following.

   a. 1 kilogram = _____ gram(s)

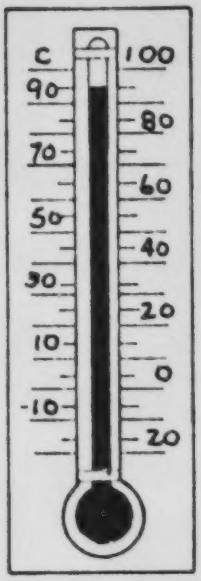
   b. 1 gram = _____ gram(s)

11. Write the symbol for the metric units.

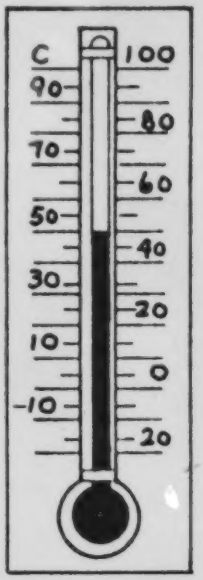
   a. gram = _____

   b. kilogram = _____

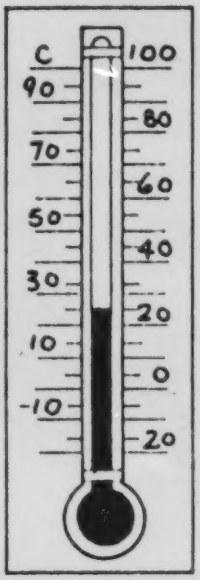
12. Write the temperature shown on each thermometer.

a. 

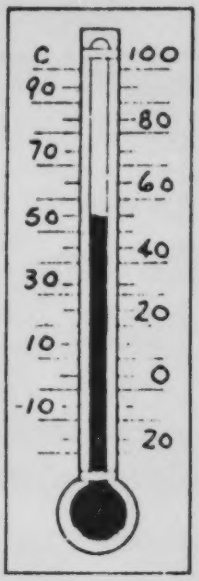
_____ C

b. 

_____ C

c. 

_____ C

d. 

_____ C

13. Complete the following:

a. The boiling point of water is _____ °C.

b. The freezing point of water is _____ °C.

METRIC POST-TEST ANSWERS

Grade 3

1. a. 100
   b. 1
   c. 1000

2. a. m
   b. cm
   c. km

3. a. 3
   b. 6
   c. 2
   d. 5

4. a. Teacher judgment
   b. Teacher judgment
   c. Teacher judgment
   d. Teacher judgment

5. a. 2
   b. 600
   c. 3
   d. 500
   e. 7
   f. 2
   g. 4000
   h. 2000

6. a. 24
   b. 20
   c. 8
   d. 14

7. a. 1000
   b. 1

8. a. ℓ
   b. ml

9. a. 5 ℓ
   b. 2000 ml
   c. 4000 ml
   d. 2 ℓ

10. a. 1000
    b. 1

11. a. g
    b. kg

12. a. 95°
    b. 50°
    c. 25°
    d. 55°

13. a. 100
    b. 0

METRIC PRE-TEST

Grade 4

_____ _____

Date Name

1. Complete the following.

   a. 1 dekametre = _____ metre(s)

   b. 1 metre = _____ centimetre(s)

   c. 1 metre = _____ metre(s)

   d. 1 hectometre = _____ metre(s)

   e. 1 metre = _____ millimetre(s)

   f. 1 metre = _____ decimetre(s)

   g. 1 kilometre = _____ metre(s)

2. Write the symbol for the metric units.

   a. kilometre = _____

   b. millimetre = _____

   c. decimetre = _____

   d. dekametre = _____

   e. centimetre = _____

   f. hectometre = _____

   g. metre = _____

3. Complete the following.

a. 400 cm = _____ m

b. 30 dm = _____ m

c. 2000 m = _____ km

d. 20 mm = _____ cm

e. 1000 m = _____ km

f. 50 dm = _____ m

g. 70 mm = _____ cm

h. 900 cm = _____ m

4. Estimate the length of the line segments to the nearest centimetre.

a. _____ _____ cm

b. _____ _____ cm

c. _____ _____ cm

d. _____ _____ cm

5. Circle which one is longer.

   a. 2 cm or 2 dm

   b. 14 cm or 3 dm

   c. 55 cm or 2 dm

   d. 13 mm or 7 cm

   e. 25 mm or 1 cm

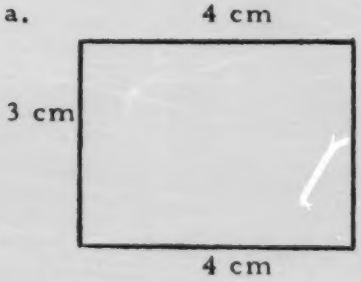
   f. 300 cm or 1 m

   g. 10 m or 60 cm

   h. 80 cm or 1 m

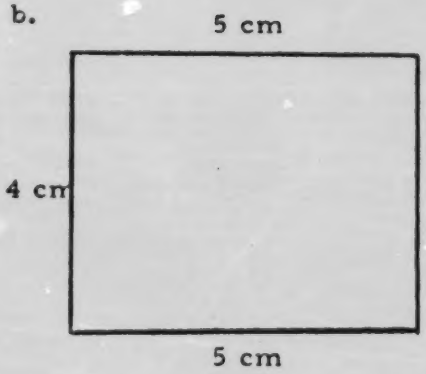
6. Find the perimeter of each polygon.

a.



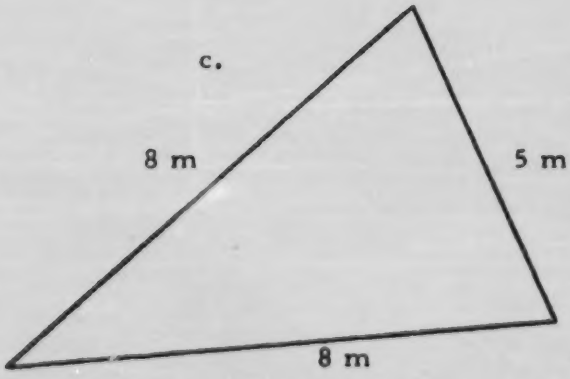
_____ cm

b.



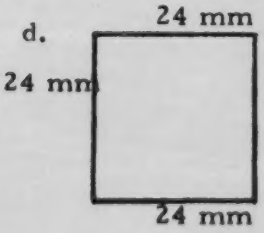
_____ cm

c.



_____ m

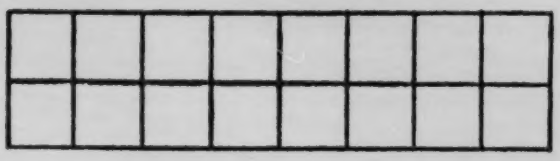
d.



_____ mm

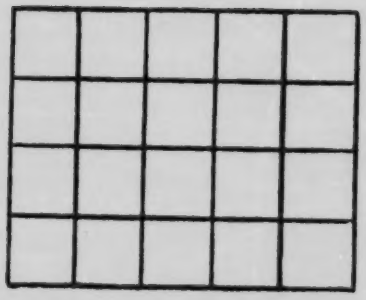
7. Find the area of each rectangle if each square is one square centimetre.

a.



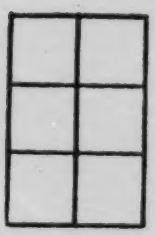
____ cm^2

b.



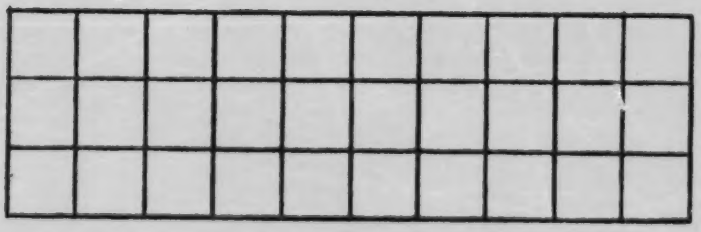
____ cm^2

c.



____ cm^2

d.



____ cm^2

8. Complete the following.

   a. 1 litre = _____ litre(s)

   b. 1 kilolitre = _____ litre(s)

   c. 1 litre = _____ millilitre(s)

9. Write the symbol for the metric units.

   a. millilitre = _____

   b. litre = _____

   c. kilolitre = _____

10. Complete the following.

   a. 7000 ml = _____ ℓ

   b. 8 kl = _____ ℓ

   c. 6 kl = _____ ℓ

   d. 9ℓ = _____ ml

   e. 8000 ml = _____ ℓ

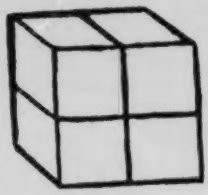
   f. 3 kl = _____ ℓ

   g. 7ℓ = _____ ml

   h. 4 kl = _____ ℓ

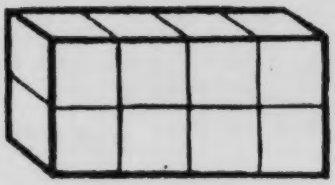
11. Find the volume of the figures by counting the cubic units.

a.



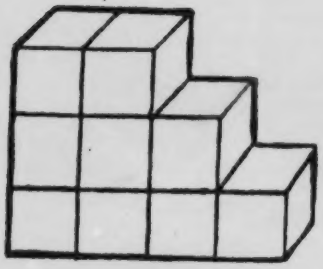
_____ cm^3

b.



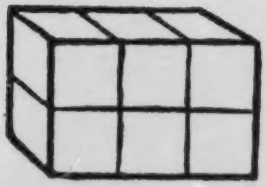
_____ cm^3

c.



_____ cm^3

d.



_____ cm^3

12. Complete the following.

    a. 1 gram = _____ gram(s)

    b. 1 kilogram = _____ gram(s)

13. Write the symbol for the metric units.

    a. kilogram = _____

    b. gram = _____

14. Complete the following.

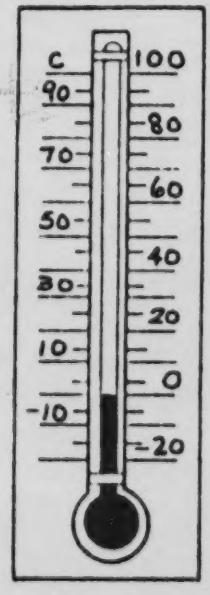
    a. 7 kg = _____ g

    b. 2000 g = _____ kg

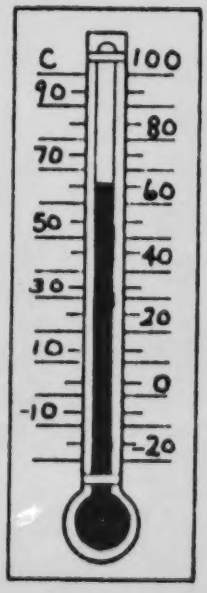
    c. 9 kg = _____ g

    d. 5000 g = _____ kg

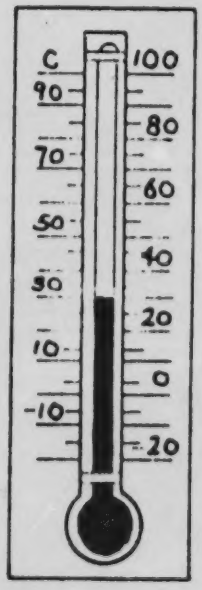
15. Write the temperature shown on each thermometer.

a. 

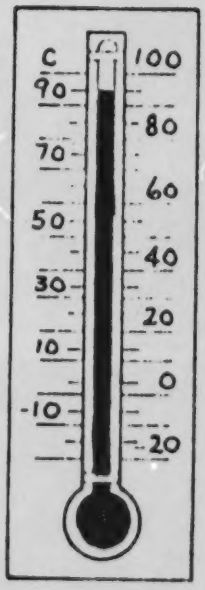
_____ C

b. 

_____ C

c. 

_____ C

d. 

_____ C

16. Complete the following.

a. The freezing point of water is _____ °C.

b. Normal room temperature is _____ °C.

c. The boiling point of water is _____ °C.

d. The normal body temperature is _____ °C.

METRIC PRE-TEST ANSWERS

Grade 4

1. a. 10
   b. 100
   c. 1
   d. 100
   e. 1000
   f. 10
   g. 1000

2. a. km
   b. mm
   c. dm
   d. dam
   e. cm
   f. hm
   g. m

3. a. 4
   b. 3
   c. 2
   d. 2
   e. 1
   f. 5
   g. 7
   h. 9

4. a. 8
   b. 3
   c. 11
   d. 7

5. a. 2 dm
   b. 3 dm
   c. 55 cm
   d. 7 cm
   e. 25 mm
   f. 300 cm
   g. 10 m
   h. 1 m

6. a. 14
   b. 18
   c. 21
   d. 96

7. a. 16
   b. 20
   c. 6
   d. 30

8. a. 1
   b. 1000
   c. 1000

9. a. ml
   b. l
   c. kl

10. a. 7
    b. 8000
    c. 6000
    d. 9000
    e. 8
    f. 3000
    g. 7000
    h. 4000

11. a. 4
    b. 8
    c. 9
    d. 6

12. a. 1
    b. 1000

13. a. kg
    b. g

14. a. 7000
    b. 2
    c. 9000
    d. 5

15. a. 0°
    b. 65°
    c. 30°
    d. 95°

16. a. 0
    b. 20
    c. 100
    d. 37

METRIC POST-TEST

Grade 4

_____ Date

_____ Name

1. Complete the following.

   a. 1 kilometre = _____ metre(s)

   b. 1 metre = _____ decimetre(s)

   c. 1 metre = _____ millimetre(s)

   d. 1 hectometre = _____ metre(s)

   e. 1 metre = _____ metre(s)

   f. 1 metre = _____ centimetre(s)

   g. 1 dekametre = _____ metre(s)

2. Write the symbol for the metric units.

   a. metre = _____

   b. hectometre = _____

   c. centimetre = _____

   d. dekametre = _____

   e. decimetre = _____

   f. millimetre = _____

   g. kilometre = _____

3. Complete the following.

a. 300 cm = _____ m

b. 20 dm = _____ m

c. 5000 m = _____ km

d. 10 mm = _____ cm

e. 2000 m = _____ km

f. 30 dm = _____ m

g. 20 mm = _____ cm

h. 800 cm = _____ m

4. Estimate the length of the line segments to the nearest centimetre.

a. _____ _____ cm

b. _____ _____ cm

c. _____ _____ cm

d. _____ _____ cm

5. Circle which one is longer.

   a. 1 cm or 1 dm

   b. 15 cm or 2 dm

   c. 45 cm or 3 dm

   d. 15 mm or 6 cm

   e. 35 mm or 2 cm

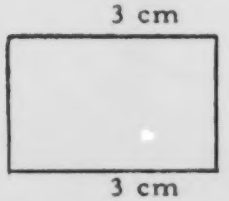
   f. 200 cm or 1 m

   g. 10 m or 70 cm

   h. 90 cm or 1 m

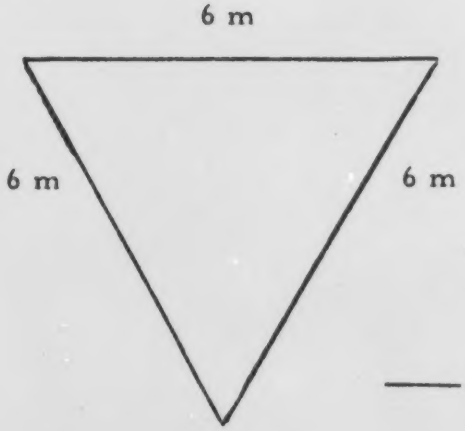
6. Find the perimeter of each polygon.

a.



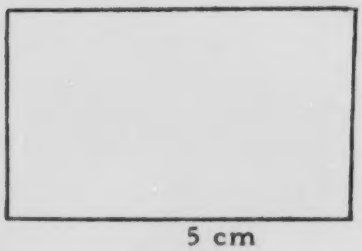
____ cm

b.



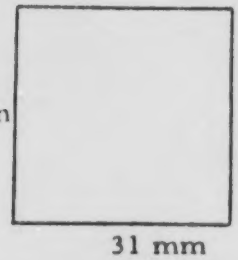
____ m

c.



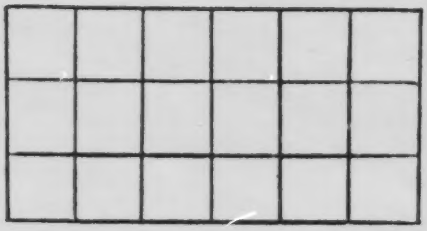
____ cm

d.

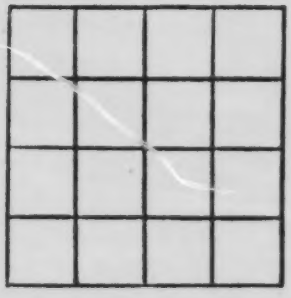


____ mm

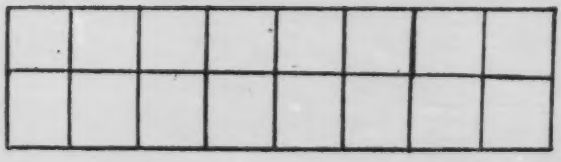
7. Find the area of each rectangle if each square is one square centimetre.

a. 

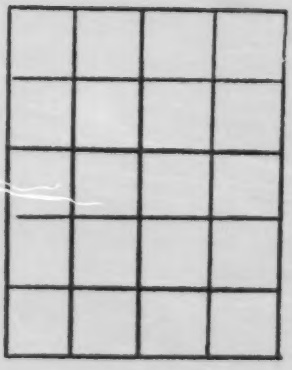
____ cm^2

b. 

____ cm^2

c. 

____ cm^2

d. 

____ cm^2

8. Complete the following.

   a. 1 litre = _____ millilitre(s)

   b. 1 kilolitre = _____ litre(s)

   c. 1 litre = _____ litre(s)

9. Write the symbol for the metric units.

   a. kilolitre = _____

   b. litre = _____

   c. millilitre= _____

10. Complete the following.

   a. 6000 ml = _____ ℓ

   b. 9 kl = _____ ℓ

   c. 5 kl = _____ ℓ

   d. 8 ℓ = _____ ml

   e. 9000 ml = _____ ℓ

   f. 4 kl = _____ ℓ

   g. 5 ℓ = _____ ml

   h. 2 kl = _____ ℓ

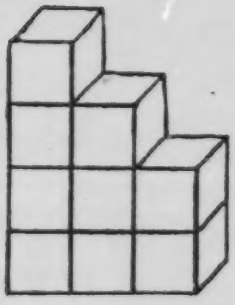
11. Find the volume of the figures by counting the cubic units.

a.

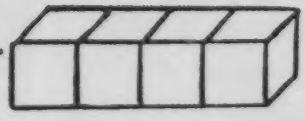
____ cm^3

b.

____ cm^3

c. 

____ cm^3

d. 

____ cm^3

12. Complete the following.

a. 1 kilogram = _____ gram(s)

b. 1 gram = _____ gram(s)

13. Write the symbol for the metric units.

a. gram = _____

b. kilogram = _____

14. Complete the following.

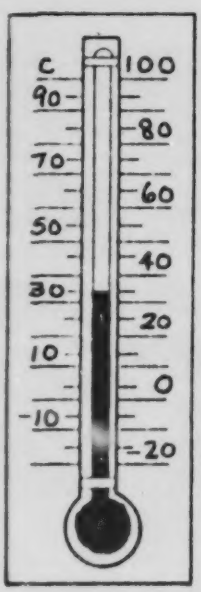
a. 6 kg = _____ g

b. 3000 g = _____ kg

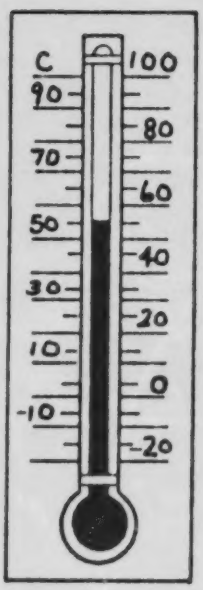
c. 8 kg = _____ g

d. 9000 g = _____ kg

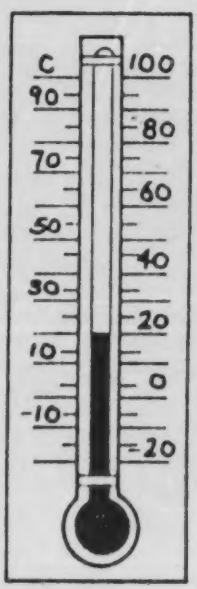
15. Write the temperature shown on each thermometer.

a. 

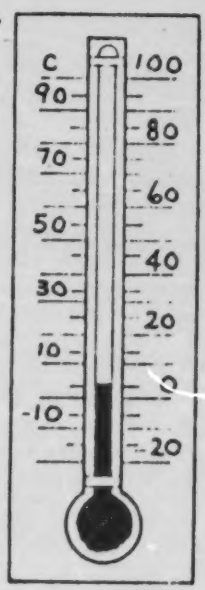
_____ C

b. 

_____ C

c. 

_____ C

d. 

_____ C

16. Complete the following.

a. The normal body temperature is _____ °C.

b. The boiling point of water is _____ °C.

c. Normal room temperature is _____ °C.

d. The freezing point of water is _____ °C.

METRIC POST-TEST ANSWERS

Grade 4

1. a. 1000
   b. 10
   c. 1000
   d. 100
   e. 1
   f. 100
   g. 10

2. a. m
   b. hm
   c. cm
   d. dam
   e. dm
   f. mm
   g. km

3. a. 3
   b. 2
   c. 5
   d. 1
   e. 2
   f. 3
   g. 2
   h. 8

4. a. 5
   b. 7
   c. 2
   d. 10

5. a. 1 dm
   b. 2 dm
   c. 45 cm
   d. 6 cm
   e. 35 mm
   f. 200 cm
   g. 10 m
   h. 1 m

6. a. 10
   b. 18
   c. 16
   d. 124

7. a. 18
   b. 16
   c. 16
   d. 20

8. a. 1000
   b. 1000
   c. 1

9. a. kl
   b. ℓ
   c. ml

10. a. 6
    b. 9000
    c. 5000
    d. 8000
    e. 9
    f. 4000
    g. 5000
    h. 2000

11. a. 8
    b. 5
    c. 9
    d. 4

12. a. 1000
    b. 1

13. a. g
    b. kg

14. a. 6000
    b. 3
    c. 8000
    d. 9

15. a. 35°
    b. 55°
    c. 20°
    d. 5°

16. a. 37
    b. 100
    c. 20
    d. 0

METRIC PRE-TEST

Grade 5

_____ Date

_____ Name

1. Write the decimal number for each of the metric units.

   a. 1 hectometre = _____ metre(s)

   b. 1 millimetre = _____ metre(s)

   c. 1 decimetre = _____ metre(s)

   d. 1 kilometre = _____ metre(s)

   e. 1 metre = _____ metre(s)

   f. 1 dekametre = _____ metre(s)

   g. 1 centimetre = _____ metre(s)

2. Write the symbol for the metric units.

   a. kilometre = _____

   b. millimetre = _____

   c. decimetre = _____

   d. dekametre = _____

   e. centimetre = _____

   f. hectometre = _____

   g. metre = _____

3. Complete the following.

a. 400 cm = _____ m

b. _____ dm = 2 m

c. _____ m = 7 km

d. 30 mm = _____ cm

e. 8000 m = _____ km

f. 40 dm = _____ m

g. _____ mm = 5 cm

h. _____ cm = 3 m

4. Estimate the length of the line segments to the nearest centimetre.

a. _____ _____ cm

b. _____ _____ cm

c. _____ _____ cm

d. _____ _____ cm

5. Circle the correct answer.

   a. A metre is

      1. a little less than a yard.

      2. the same as a yard.

      3. a little more than a yard.

   b. A kilometre is

      1. a little more than one-half mile.

      2. a little more than two miles.

      3. a little more than a mile.

   c. A centimetre is

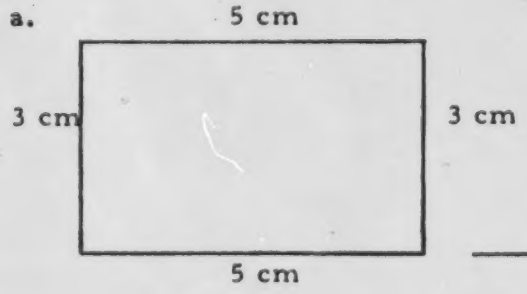
      1. a little less than one-half inch.

      2. a little less than an inch.

      3. a little more than an inch.

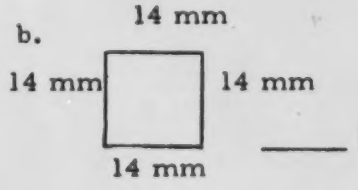
6. Find the perimeter of each polygon.

a.



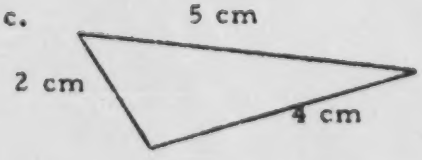
_____ cm

b.



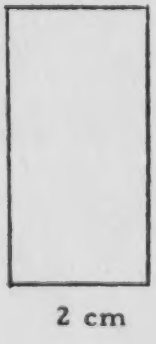
_____ mm

c.



_____ cm

d.



_____ cm

7. Construct the following figures.

a. A square with the sides 1.5 cm.

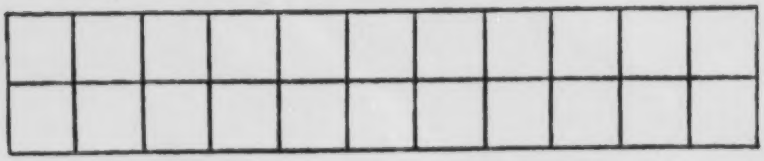
b. A rectangle with length 22 mm and width 13 mm.

c. A square with the sides 3 cm.

d. A rectangle with length 9 cm and width 4 cm.

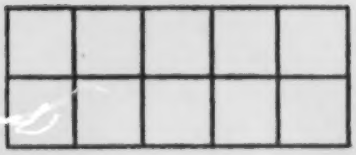
8. Find the area of each rectangle if each square is one square centimetre.

a.



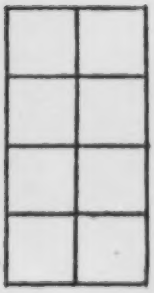
_____ cm^2

b.



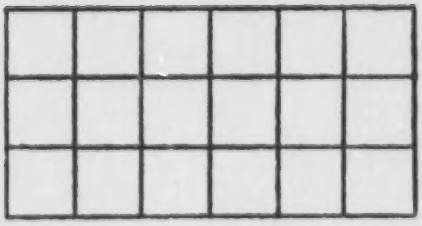
_____ cm^2

c.



_____ cm^2

d.



_____ cm^2

9. Find the area of each rectangle.

	Length	Width	Area
a.	14 mm	4 mm	_____ mm^2
b.	2 cm	8 cm	_____ cm^2
c.	6 m	7 m	_____ m^2

10. Find the missing dimension.

	Length	Width	Area
a.	9 cm	_____	27 cm^2
b.	_____	4 cm	24 cm^2
c.	5 cm	_____	35 cm^2

11. Write the decimal number for each of the metric units.

a. 1 millilitre = _____ litre(s)

b. 1 kilolitre = _____ litre(s)

c. 1 litre = _____ litre(s)

12. Write the symbol for the metric units.

a. litre = _____

b. millilitre = _____

c. kilolitre = _____

13. Complete the following.

a. 4 kl = _____ ℓ

b. 5ℓ = _____ ml

c. 6 kl = _____ ℓ

d. 3000 ml = _____ ℓ

e. 7ℓ = _____ ml

f. 10 kl = _____ ℓ

g. 14 kl = _____ ℓ

h. 9000 ml = _____ ℓ

14. Find the volume.

	Length	Width	Height	Volume
a.	3 cm	4 cm	4 cm	_____ cm^3
b.	7 cm	10 cm	10 cm	_____ cm^3
c.	10 cm	30 cm	100 cm	_____ cm^3

15. Write the decimal number for each of the metric units.

a. 1 gram = _____ gram(s)

b. 1 milligram = _____ gram(s)

c. 1 kilogram = _____ gram(s)

16. Write the symbol for the metric units.

a. kilogram = _____

b. gram = _____

c. milligram = _____

17. Indicate by each item if you would use the unit gram or kilogram to measure its mass.

a. paper plate _____

b. typewriter _____

c. newspaper _____

d. chair _____

e. stove _____

f. pen _____

g. small can of soup _____

h. woman _____

18. Complete the following.

a. 6000 mg = _____ g

b. 13 kg = _____ g

c. 5 mg = _____ g

d. 9 g = _____ mg

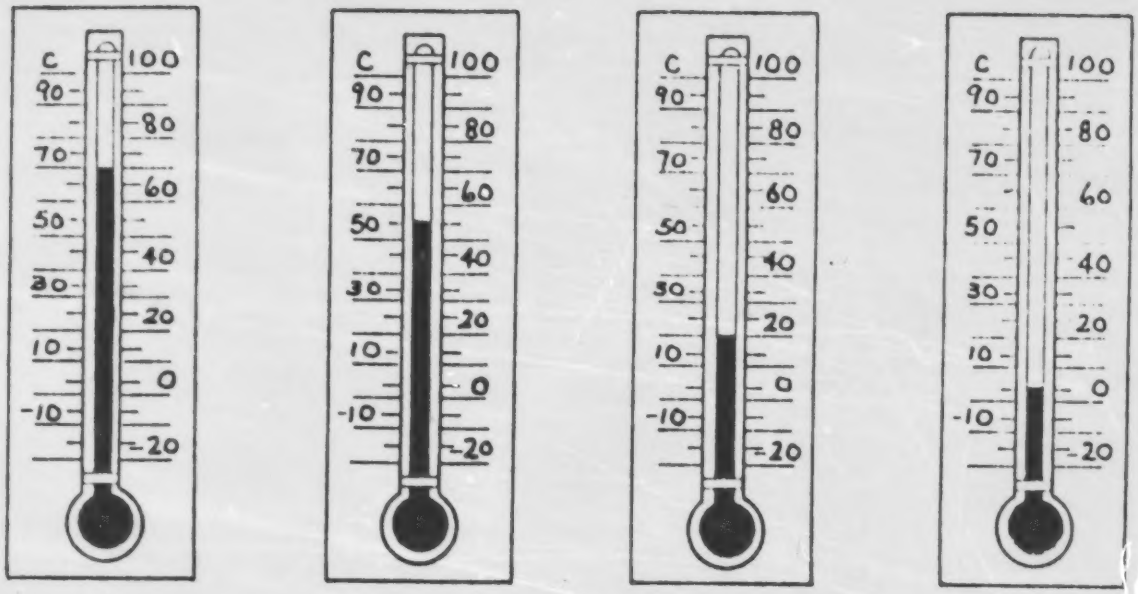
e. 2000 mg = _____ g

f. 3 kg = _____ g

g. 6 g = _____ mg

h. 4 kg = _____ g

19.



_____ _____ _____ _____

20. Write yes or no in front of each question.

a. _____ Would you burn your hand if you put it in water which was 90 °C?

b. _____ Could you go ice skating if the temperature was 10 °C?

c. _____ If the temperature inside a refrigerator was 25 °C would the food stay cold?

d. _____ Would you be hot if the temperature was 35 °C?

METRIC PRE-TEST ANSWERS

Grade 5

1. a. 100
   b. 0.001
   c. 0.1
   d. 1000
   e. 1
   f. 10
   g. 0.01

2. a. km
   b. mm
   c. dm
   d. dam
   e. cm
   f. hm
   g. m

3. a. 4
   b. 20
   c. 7000
   d. 3
   e. 8
   f. 4
   g. 50
   h. 300

4. a. 5
   b. 9
   c. 3
   d. 6

5. a. (3)
   b. (1)
   c. (1)

6. a. 16
   b. 56
   c. 11
   d. 12

7. a. Teacher judgment
   b. Teacher judgment
   c. Teacher judgment
   d. Teacher judgment

8. a. 22
   b. 10
   c. 8
   d. 18

9. a. 56
   b. 16
   c. 42

10. a. 3 cm
    b. 6 cm
    c. 7 cm

11. a. 0.001
    b. 1000
    c. 1

12. a. ℓ
    b. ml
    c. kl

13. a. 4000
    b. 5000
    c. 6000
    d. 3
    e. 7000
    f. 10 000
    g. 14 000
    h. 9

14. a. 48
    b. 700
    c. 30 000

15. a. 1
    b. 0.001
    c. 1000

16. a. kg
    b. g
    c. mg

17. a. gram
    b. kilogram
    c. gram
    d. kilogram
    e. kilogram
    f. gram
    g. gram
    h. kilogram

18. a. 6
    b. 13 000
    c. 0.005
    d. 9000
    e. 2
    f. 3000
    g. 6000
    h. 4000

19. a. 70°
    b. 55°
    c. 20°
    d. 5°

20. a. yes
    b. no
    c. no
    d. yes

METRIC POST-TEST

Grade 5

_____ Date

_____ Name

1. Write the decimal number for each of the metric units.

   a. 1 centimetre = _____ metre(s)

   b. 1 dekametre = _____ metre(s)

   c. 1 metre = _____ metre(s)

   d. 1 kilometre = _____ metre(s)

   e. 1 decimetre = _____ metre(s)

   f. 1 millimetre = _____ metre(s)

   g. 1 hectometre = _____ metre(s)

2. Write the symbol for the metric units.

   a. metre = _____

   b. hectometre = _____

   c. centimetre = _____

   d. dekametre = _____

   e. decimetre = _____

   f. millimetre = _____

   g. kilometre = _____

3. Complete the following.

a. 500 cm = _____ m

b. _____ dm = 3 m

c. _____ m = 6 km

d. 20 mm = _____ cm

e. 9000 m = _____ km

f. 50 dm = _____ m

g. _____ mm = 4 cm

h. _____ cm = 2 m

4. Estimate the length of the line segments to the nearest centimetre.

a. _____ _____ cm

b. _____ _____ cm

c. _____ _____ cm

d. _____ _____ cm

5. Circle the correct answer.

a. A metre is

(1) a little more than a yard.

(2) the same as a yard.

(3) a little less than a yard.

b. A kilometre is

(1) a little more than a mile.

(2) a little more than two miles.

(3) a little more than one-half mile.

c. A centimetre is

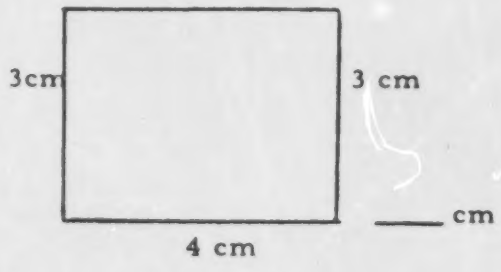
(1) a little more than an inch.

(2) a little less than an inch.

(3) a little less than one-half inch.

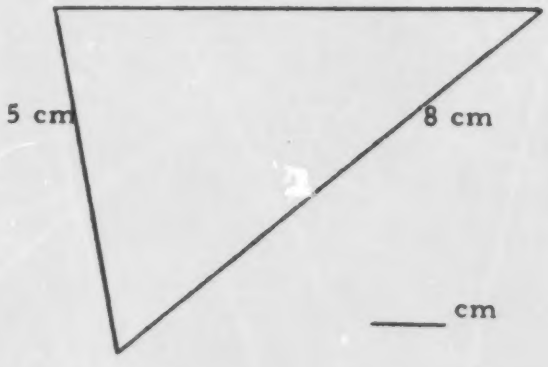
6. Find the perimeter of each polygon.

a.



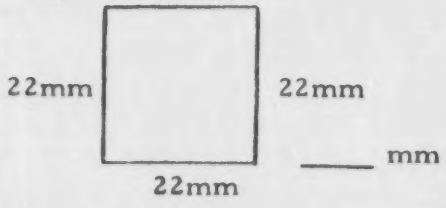
____ cm

b.



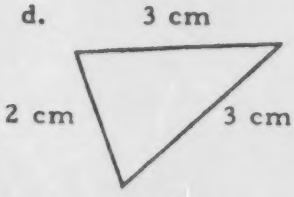
____ cm

c.



____ mm

d.



____ cm

7. Construct the following figures.

a. A square with the sides 2.5 cm.

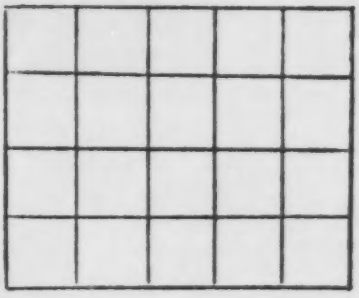
b. A rectangle with length 24 mm and width 11 mm.

c. A square with the sides 4 cm.

d. A rectangle with length 8 cm and width 3 cm.

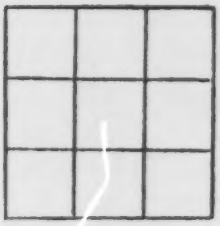
8. Find the area of each rectangle if each square is one square centimetre.

a.



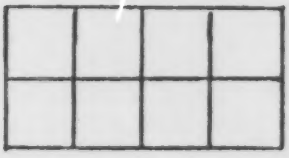
____ cm^2

b.



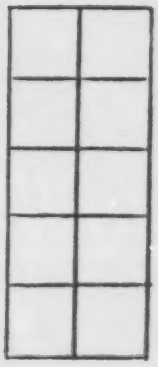
____ cm^2

c.



____ cm^2

d.



____ cm^2

9. Find the area of each rectangle.

	Length	Width	Area
a.	12 mm	3 mm	_____ mm^2
b.	3 cm	9 cm	_____ cm^2
c.	4 m	6 m	_____ m^2

10. Find the missing dimension:

	Length	Width	Area
a.	7 cm	_____	28 cm^2
b.	_____	3 cm	18 cm^2
c.	3 cm	_____	36 cm^2

11. Write the decimal number for each of the metric units.

a. 1 litre = _____ litre(s)

b. 1 kilolitre = _____ litre(s)

c. 1 millilitre = _____ litre(s)

12. Write the symbol for the metric units.

a. kilolitre = _____

b. millilitre = _____

c. litre = _____

13. Complete the following

a. 3 kl = _____ ℓ

b. 6 ℓ = _____ ml

c. 5 kl = _____ ℓ

d. 2000 ml = _____ ℓ

e. 9 ℓ = _____ ml

f. 10 kl = _____ ℓ

g. 15 kl = _____ ℓ

h. 7000 ml = _____ ℓ

14. Find the volume.

	Length	Width	Height	Volume
a.	2 cm	3 cm	4 cm	_____ cm^3
b.	8 cm	10 cm	10 cm	_____ cm^3
c.	20 cm	20 cm	100 cm	_____ cm^3

15. Write the decimal number for each of the metric units.

a. 1 kilogram = _____ gram(s)

b. 1 milligram = _____ gram(s)

c. 1 gram = _____ gram(s)

16. Write the symbol for the metric units.

a. milligram = _____

b. gram = _____

c. kilogram = _____

17. Indicate by each item if you would use the unit gram or kilogram to measure its mass.

a. man _____

b. small can of juice _____

c. pencil _____

d. television set _____

e. desk _____

f. letter _____

g. car tire _____

h. paper cup _____

18. Complete the following.

a. 5000 mg = _____ g

b. 12 kg = _____ g

c. 6 mg = _____ g

d. 8 g = _____ mg

e. 3000 mg = _____ g

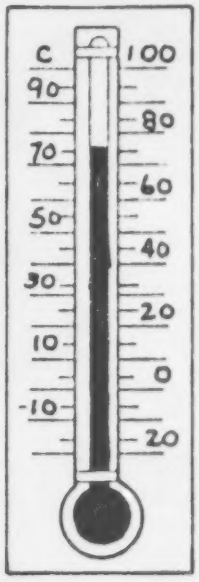
f. 4 kg = _____ g

g. 7 g = _____ mg

h. 2 kg = _____ g

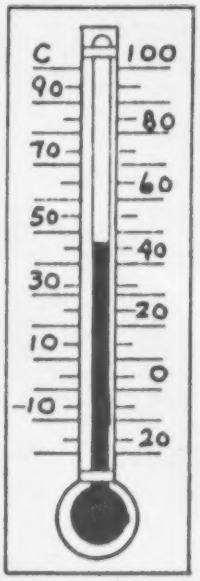
19. Write the temperature shown on each thermometer.

a.



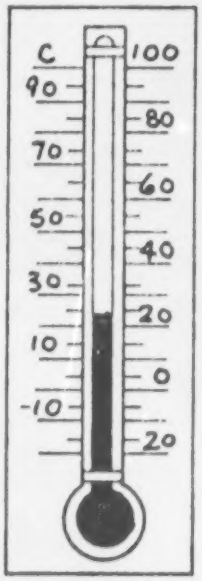
_____ C

b.



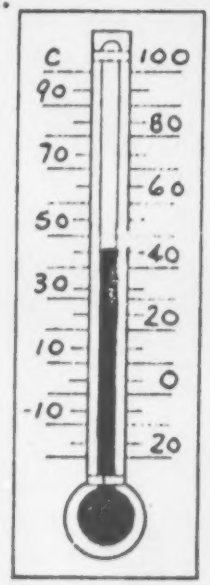
_____ C

c.



_____ C

d.



_____ C

20. Write yes or no in front of each question.

a. _____ Would you need your winter coat if the temperature was 20° C?

b. _____ Would the outdoor swimming pool be open if the temperature was 15° C?

c. _____ If your temperature was 40 °C would you have a fever?

d. _____ Would you be hot in a room if the temperature was 27° C?

METRIC POST-TEST ANSWERS

Grade 5

1. a. 0.01
   b. 10
   c. 1
   d. 1000
   e. 0.1
   f. 0.001
   g. 100

2. a. m
   b. hm
   c. cm
   d. dam
   e. dm
   f. mm
   g. km

3. a. 5
   b. 30
   c. 6000
   d. 2
   e. 9
   f. 5
   g. 40
   h. 200

4. a. 8
   b. 2
   c. 6
   d. 10

5. a. (1)
   b. (3)
   c. (3)

6. a. 14
   b. 20
   c. 88
   d. 8

7. a. Teacher judgment
   b. Teacher judgment
   c. Teacher judgment
   d. Teacher judgment

8. a. 20
   b. 9
   c. 8
   d. 10

9. a. 36
   b. 27
   c. 24

10. a. 4 cm
    b. 6 cm
    c. 12 cm

11. a. 1
    b. 1000
    c. 0.001

12. a. kl
    b. ml
    c. l

13. a. 3000
    b. 6000
    c. 5000
    d. 2
    e. 9000
    f. 10 000
    g. 15 000
    h. 7

14. a. 24
    b. 800
    c. 40 000

15. a. 1000
    b. 0.001
    c. 1

16. a. mg
    b. g
    c. kg

17. a. kg
    b. g
    c. g
    d. kg
    e. kg
    f. g
    g. kg
    h. g

18. a. 5
    b. 12 000
    c. 0.006
    d. 8000
    e. 3
    f. 4000
    g. 7000
    h. 2000

19. a. 75 °
    b. 45 °
    c. 25 °
    d. 50 °

20. a. No
    b. No
    c. Yes
    d. Yes

MASTERY LEVEL FOR STUDENT OBJECTIVES

Objective	Number of Answers	Mastery Level
	Grade 1	
1	2	2
2	6	5
3	7	5
4	4	3
5	1	1
6	1	1
7	4	3
	Grade 2	
1	4	3
2	2	2
3	6	5
4	4	3
5	2	2
6	1	1
7	4	3
8	2	2
9	4	3
	Grade 3	
1	3	3
2	3	3
3	4	3
4	4	
5	8	6
6	4	3
7	2	2
8	2	2
9	4	3
10	2	2
11	2	2
12	4	3
13	2	2

Grade 4

1	7	5
2	7	5
3	8	6
4	4	3
5	8	6
6	4	3
7	4	3
8	3	3
9	3	3
10	8	6
11	4	3
12	2	2
13	2	2
14	4	3
15	4	3
16	4	3

Grade 5

1	7	5
2	7	5
3	8	6
4	4	3
5	3	3
6	4	3
7	4	3
8	4	3
9	3	3
10	3	3
11	3	3
12	3	3
13	8	6
14	3	3
15	3	3
16	3	3
17	8	6
18	8	6
19	3	3
20	3	3

OBJECTIVES AND NUMBER OF TEST ITEMS FOR EACH OBJECTIVE

Grade 2

Objective	Item Numbers
1	1, 2, 3, 4
2	5, 6
3	7, 8
4	9
5	10, 11
6	12
7	13, 14, 15, 16
8	17, 18
9	19

EVALUATION OF METRIC BOOKS USED IN UNITS

Books	Consistency with SI Guidelines*	Activity Oriented	Grade Level(s)
1	Partially consistent, er, conversions	No	5
2	Inconsistent, er, (4, 7, 9)	Yes	1-5
3	Inconsistent, er, (4, 7, 9)	No	1-5
4	Consistent, re	No	4-6
5	Consistent, er	Yes	4-6
6	Partially consistent, er, (7)	Yes	5
7	Partially consistent, er, (9) conversions	No	4-6
8	Partially consistent, er, (7, 9) conversions	No	1-5
9	Consistent, er	Yes	5-8
10	Consistent, er	Yes	1-5
11	Consistent, re	Yes	4-6
12	Partially consistent, er, (4)	Yes	1-5

13	Partially consistent, er, (4, 9)	No	5 and up
14	Inconsistent, er, (1, 4, 7) conversions	Yes	1-5
15	Partially consistent, er (7)	Yes	4
16	Partially consistent, er, conversions	Yes	4-6
17	Partially consistent, er, (1, 5) conversions	Yes	4-6
18	Partially consistent, er, conversions	Yes	1-6
19	Consistent, er	No	5
20	Consistent, re	Yes	1-3
21	Consistent, re	Yes	4-6
22	Partially consistent, er (7)	Yes	4
23	Consistent, er	Yes	1-4
24	Consistent, er	Yes	3
25	Partially consistent, er, (4, 7)	Yes	4-6
26	Consistent, re	Yes	1-3

27	Consistent, re	Yes	1-3
28	Consistent, er	Yes	1-3
29	Partially consistent, er, conversions	No	1-3
30	Consistent, er	Yes	1-3

*Books were evaluated according to the SI guidelines given in appendix SS. The numbers in parentheses refer to rules which were not followed in a particular book. Use of conversion between the metric system and the customary system is noted as well as the use of er or re in spelling metric words.

EVALUATION OF METRIC GAMES,
CHARTS, AND KITS USED IN UNITS

	Consistency with SI Guidelines	Activity Oriented	Grade Level(s)
Metric Bingo	Partially consistent, er, (8) conversions	Yes	3-12
Metric Fun Posters	Consistent, er	Yes	3-6
Beginner's Metric System	Partially consistent, er, (1)	Yes	2-5
Measure Up	Consistent, er	Yes	1-3
Metric Quizmo	Consistent, re	Yes	5
Metric Playing Cards	Partially consistent, er, (1)	Yes	5
Classroom Metric Lines	Partially Consistent, er, (1) conversions	Yes	1-5
Metric Fun Activity Cards A and B	Partially consistent, er, (7)	Yes	1-3 and 4-6
Metric Fun Cooking Cards	Consistent, er	Yes	3-5
Metric Mice	Consistent, re	Yes	3-5
Going Metric Kit	Consistent, er	Yes	4-6

Early Metric Books	Partially consistent, er, (1, 7)	Yes	2-5
Metric Match	Consistent, re	Yes	5
Metric Market	Consistent, er	Yes	4-5
Hometrics Kit	Consistent, re	Yes	4-5
Veri Tech	Consistent, re	Yes	5-12
Metric Bag	Partially consistent, er, (7) conversions	Yes	4-8
Metric Box	Partially consistent, re, (8)	Yes	3-5
Starting Points	Consistent, er	Yes	3-5
Centimetre by Centimetre	Partially consistent, re, (4)	Yes	3-6
Measuring Metric Lengths	Consistent, er	Yes	1-3
Flip Chek	Consistent, re	Yes	1-3
Task Cards	Consistent, er	Yes	5-6
Decimetre	Consistent, re	Yes	4-6

BOOKS LISTED IN UNITS

1. Metric Measurement
2. Holt Metric Activity Masters
3. Holt Metrication Masters
4. Metric Math
5. Think Metric - Blue Level
6. Meters, Liters, and Grams - Level 5
7. Exploring the Metric System
8. Contemporary Metrics
9. Metrics in Action
10. Teaching the Metric System
11. Happy Metrics II - Intermediate
12. Fun and Games with Metrics
13. Amusements in Developing Metric Skills
14. I'm O.K. - You're O.K., Let's Go Metric
15. Metric Skills
16. Metric Magic
17. The Metric System
18. Learning Center Ideabook
19. Teacher's Handbook of Metric Activities
20. Guide to Metric Measurement - Book I
21. Guide to Metric Measurement - Book II
22. Meters, Liters, and Grams - Level 4
23. Think Metric - Red Level
24. Meters, Liters, and Grams - Level 3
25. Fun with Metric Measurement
26. Happy Metrics I - Primary
27. The Measurement Book
28. Early Childhood Metric Fun Book
29. Beginning Metrics
30. Measure Metric

METRIC UNIT

Grade 1

Introduction to Metrics

Books
- 10 - pp. 3 - 8
- 12 - pp. 87 - 90
- 19 - pp. 1 - 10
- 21 - pp. iii - vi
- 23 - pp. T3 - T5
- 25 - pp. 1 - 5
- 27 - pp. 3 - 4
- 28 - pp. 2 - 3

Games, Charts, and Kits
- Starting Points

Length

Books
- 2 - pp. 2 - 4
- 14 - pp. NR1 - NR 3
- 18 - p. 92
- 20 - p. 23, 45, 48
- 23 - pp. 6 - 8, 10 - 11, 19, 21 - 22, 24
- 25 - pp. 19, 31
- 27 - pp. 8 - 11, 16 - 17, 20 - 21, 26 - 27, 30 - 33, 44 - 45, 48 - 51
- 29 - pp. 36, 38
- 30 - pp. 1 - 2, 5 - 7, 28

Holt Math Book - pp. 251 - 253, 257 - 258, 261 - 262

Games, Charts, and Kits
- Classroom Metric Lines
- Measure Up
- Measuring Metric Length
- Flip Chek - Length

Mass

Books
- 18 - p. 96
- 20 - pp. 11 - 13, 51
- 23 - pp. 36 - 37
- 25 - p. 68
- 27 - pp. 128 - 139
- 28 - pp. 6, 61 - 62

Volume

Books
- 18 - p. 101
- 20 - p. 17
- 23 - pp. 62
- 25 - p. 62
- 27 - pp. 100 - 107, 122 - 123
- 28 - pp. 7, 57

Temperature

Books
- 15 - p. 23
- 23 - p. 56
- 25 - p. 79
- 27 - pp. 172 - 175
- 28 - pp. 68 - 69

Games, Charts, and Kits
- Ideal Thermometer

Combination of Areas

Games, Charts, and Kits
- Metric Fun Activity Cards - Set A
- Metric Cook 'N Color
- Metric Circus

METRIC UNIT

Grade 2

Introduction to Metrics

Books
- 10 - pp. 3 - 8
- 12 - pp. 87 - 90
- 19 - pp. 1 - 10
- 21 - pp. iii - vi
- 23 - pp. T3 - T5
- 25 - pp. 1 - 5
- 27 - pp. 3 - 4
- 28 - pp. 2 - 3

Games, Charts, and Kits
- Starting Points

Length

Books
- 2 - pp. 2 - 4
- 14 - pp. NR1 - NR3, NR6 - NR7
- 18 - p. 92
- 20 - p. 23
- 23 - pp. 6 - 8, 10 - 12, 19, 21 - 22, 24
- 25 - pp. 19 , 31
- 27 - pp. 8 - 11, 14 - 17, 20 - 21, 49 - 51
- 28 - pp. 4 - 5, 9 - 12, 15 - 19, 21, 23, 25 - 29, 33, 41 - 49
- 29 - pp. 36 - 40
- 30 - pp. 1 - 11, 28, 30 - 31

Holt Math Book - pp. 221 - 222, 227

Games, Charts, and Kits
- Classroom Metric Lines
- Early Metric Book - Meter
- Measure Up
- Measuring Metric Length
- Flip Chek - Length

Mass

Books
- 18 - p. 96
- 20 - pp. 11 - 14
- 23 - pp. 36 - 37, 48
- 25 - p. 68
- 26 - p. 88
- 27 - pp. 146 - 147, 158, 162 - 165
- 28 - pp. 6, 59, 61-63, 65 - 67

Games, Charts, and Kits
- Early Metric Book - Gram

Volume

Books
- 18 - p. 101
- 20 - p. 17
- 23 - pp. 50 - 54
- 25 - pp. 62 - 63
- 26 - p. 91
- 27 - pp. 200 - 105, 122 - 123
- 28 - pp. 7, 55 - 57

Games, Charts, and Kits
- Early Metric Book - Liter

Temperature

Books
- 15 - p. 23
- 20 - p. 19
- 23 - pp. 56, 59
- 25 - p. 79
- 27 - pp. 172 - 177
- 28 - pp. 68 - 69

Games, Charts, and Kits
- Early Metric Book - Thermometer
- Ideal Thermometer

Combination of Areas

Games, Charts, and Kits
- Metric Fun Posters
- Beginner's Metric System
- Metric Fun Activity Cards - Set A
- The Good Apple Math Book - pp. 133 - 144
- Metric Cook 'N Color
- Metric Circus

METRIC UNIT

Grade 3

Introduction to Metrics

Books
- 10 - pp. 3 - 8
- 12 - pp. 87 - 90
- 19 - pp. 1 - 10
- 21 - pp. iii - vi
- 23 - pp. T3 - T5
- 24 - pp. 4 - 5
- 25 - pp. 1 - 5
- 27 - pp. 3 - 4
- 28 - pp. 2 - 3

Games, Charts, and Kits
- Starting Points

Length

Books
- 2 - pp. 2 - 4
- 8 - pp. (1 - 1) - (1 - 3)
- 12 - pp. 17 - 18, 78
- 14 - pp. NR1 - NR3, NR6 - NR 7, LR8, HR17
- 15 - pp. 2, 8
- 18 - p. 92
- 20 - pp. 3 - 4, 23 - 26
- 23 - pp. 6 - 15, 19, 21 - 24, 27 - 30, 32
- 24 - pp. 6 - 9, 17 - 24, 30 - 35
- 25 - pp. 7 - 8, 12, 19, 21 - 23, 29 - 32, 37 - 38, 43
- 27 - pp. 50 - 53, 56 - 59
- 28 - pp. 17 - 19, 21 - 24, 26, 28, 30, 37 - 39, 41 - 49, 52
- 29 - pp. 36 - 40
- 30 - pp. 8 - 17, 22 - 23, 30 - 31

Games, Charts, and Kits
- Classroom Metric Lines
- Metric Mice - Length
- The Metric Box (L1 - L57)
- Centimetre by Centimetre
- Early Metric Book - Meter
- Measure Up
- Measuring Metric Length
- Flip Chek - Length

TV
- Metric Marmalade - Program 3

Perimeter

Books
- 8 - pp. (2 - 1) - (2 - 2)
- 25 - pp. 55 - 56
- 26 - p. 41

Mass

Books
- 15 - p. 3
- 18 - p. 96
- 20 - pp. 11 - 14, 31 - 33
- 23 - pp. 36 - 37, 39 - 41, 44, 47 - 48
- 24 - pp. 48 - 49, 54 - 58
- 25 - pp. 68, 71
- 26 - p. 88
- 27 - pp. 158 - 159, 162, 167
- 28 - pp. 59, 61 - 67, 72

Games, Charts, and Kits
- Metric Mice - Mass
- Early Metric Book - Gram
- The Metric Box (W1 - W53)

TV
- Metric Marmalade - Program 10

Volume

Books
- 18 - p. 101
- 20 - pp. 16 - 17, 35 - 37
- 23 - pp. 50 - 54
- 24 - pp. 36 - 40, 44, 46
- 25 - pp. 62 - 63
- 26 - p. 81
- 27 - pp. 112 - 113, 122 - 125
- 28 - pp. 55 - 58
- 29 - p. 59

Games, Charts, and Kits
- Metric Mice - Volume
- Early Metric Book - Liter
- The Metric Box - (V1 - V12)

Temperature

Books
- 15 - p. 23
- 20 - pp. 19, 39
- 23 - pp. 56 - 60
- 25 - p. 79
- 26 - p. 91
- 27 - pp. 174 - 177
- 28 - pp. 68 - 69

Games, Charts, and Kits
- Early Metric Book - Thermometer
- Ideal Thermometer

Combination of Areas

Games, Charts, and Kits
- Metric Fun Posters
- Beginner's Metric System
- Metric Fun Activity Cards - Set A
- Metric Fun Cooking Cards
- The Good Apple Math Book - pp. 133 - 144
- Metric Cook 'N Color
- Metric Circus

METRIC UNIT

Grade 4

Introduction to Metrics

Books
- 1 - pp. 1 - 6
- 5 - pp. T(3 - 5)
- 6 - pp. 1 - 3
- 7 - p. 1
- 9 - A. M. 1 - 3
- 10 - pp. 3 - 8
- 11 - p. 5
- 12 - pp. 87 - 90
- 17 - pp. 8
- 19 - pp. 1 - 10
- 21 - pp. iii - vi
- 22 - pp. 1 - 5

Games, Charts, and Kits
- Early Metric Book - The Metric System
- Starting Points

TV
- Metric Marmalade - Program 2

Length

Books
- 2 - pp. 1 - 7, 13
- 3 - pp. 4 - 5, 11, 18 - 19
- 4 - pp. 1 - 3, 5, 8, 11, 24
- 5 - pp. 5 - 14, 16, 18, 26 - 27
- 7 - pp. 2 - 7
- 8 - pp. (1 - 1) - (1 - 6), 1 - 11
- 9 - A. M. 4 - 6
- 10 - pp. 12 - 13, 17 - 18
- 11 - pp. 8 - 14, 25 - 26, 29, 93
- 12 - pp. 16 - 19, 26, 49 - 53, 78 - 80
- 13 - pp. 2, 4
- 14 - pp. NR1 - NR3, LR4 - LR5, NR6 - NR7, LR8 , MR9 - MR10 , HR17
- 15 - pp. 2, 8 - 12, 18
- 17 - pp. 2 - 20, 25 - 27
- 18 - pp. 92 - 94
- 21 - pp. 4 - 21, 34 - 35, 40
- 22 - pp. 6 - 20, 24, 26 - 27

Holt Math Book pp. 300 - 303

Games, Charts, and Kits
- Classroom Metric Lines
- Metric Mice - Length
- The Metric Box (L1 - L57)
- Centimetre by Centimetre
- Decimetre
- Early Metric Book - Meter
- Metric Bag (L1 - L29)
- Co-Basal Math - Set 4 - Measurement pp. 1 - 9
- Co-Basal Math - Set 4 - Activity Cards R4 - 2, R4 - 3, E4 - 1, E4 - 2

TV
- Metric Marmalade - Programs 3 - 6

Perimeter

Books
- 2 - pp. 16, 21
- 3 - pp. 8 - 9
- 4 - p. 6
- 5 - pp. 24 - 25, 34
- 7 - pp. 18 - 19
- 8 - pp. (2 - 1) - (2 - 3)
- 21 - p. 22
- 22 - pp. 21 - 22

Area

Books
- 2 - pp. 21 - 22
- 5 - pp. 31 - 32, 34
- 7 - pp. 20 - 21
- 8 - p. 2 - 12
- 10 - p. 20
- 11 - pp. 48 - 51
- 14 - pp. NR22, NR25, LR25, LR29
- 15 - p. 20
- 17 - pp. 31 - 32
- 18 - pp. 102 - 103
- 21 - pp. 42 - 47

Games, Charts, and Kits
Metric Mice - Area
Co-Basal Math - Set 4 - Measurement pp. 10 - 13
Co-Basal Math - Set 4 - Activity Cards R4 - 1, R4 - 4, R4 - 5, R4 - 6, E4 - 3, E4 - 4

Mass

Books
2 - pp. 34, 36 - 38
3 - p. 25
5 - pp. 48 - 50, 53
7 - pp. 42
9 - A. M. 10
10 - pp. 34 - 36
11 - pp. 75, 80 - 81, 83 - 84, 95
15 - pp. 3, 15
17 - pp. 63 - 65
18 - p. 97
20 - pp. 37
21 - pp. 56 - 67
22 - pp. 43 - 47

Games, Charts, and Kits
Metric Mice - Mass
Early Metric Book - Gram
The Metric Box (W1 - W53)
Co-Basal Math - Set 4 Measurement pp. 18 - 21
Co-Basal Math - Set 4 Activity Cards R4 - 8, R4 - 9, E4 - 8

TV
Metric Marmalade - Program 10

Volume

Books
2 - pp. 25, 27, 29
4 - pp. 20
5 - pp. 37, 39, 41 - 42, 46
7 - pp. 25 - 27, 33
9 - A. M. 8 - 9
10 - pp. 21 - 24
11 - pp. 73 - 74, 97
14 - pp. NR35 - NR37, LR47
15 - pp. 4 - 6

17 - pp. 42 - 44, 48 - 50
18 - p. 104
21 - pp. 74 - 75, 77
22 - pp. 30 - 32, 40

Holt Math Book pp. 312, 319

Games, Charts, and Kits
Metric Mice - Volume
Early Metric Book - Liter
The Metric Box 9 (V1 - V12)
Metric Bag (V1 - V14)
Co-Basal Math - Set 4 - Measurement pp. 14 - 17
Co-Basal Math - Set 4 - Activity Cards R4 - 7, E4 - 6, E4 - 7

TV
Metric Marmalade - Program 7

Temperature

Books
2 - pp. 40 - 41
3 - pp. 47 - 48
5 - pp. 59 - 62
9 - A.M. 11
10 - pp. 39 - 41
11 - pp. 85 - 86
14 - p. NR42
15 - p. 23
17 - pp. 76 - 79, 82 - 85, 93
21 - pp. 80 - 82
22 - pp. 51 - 58

Holt Math Book - p. 322

Games, Charts, and Kits
Early Metric Book - Thermometer
Metric Bag (T1 - T4)
Co-Basal Math - Set 4 - Measurement pp. 22 - 24
Co-Basal Math - Set 4 - Activity Cards R4 - 10, E4 - 5, E4 - 9, E4 - 10

Combination of Areas

Games, Charts, and Kits
- Hometrics Kit
- Metric Bingo
- Metric Fun Posters
- Beginner's Metric System
- Metric Market
- Metric Bag (A1 - A7)
- Metric Fun Activity Cards - Set B
- Going Metric
- The Good Apple Math Book - pp. 133 - 144
- Metric Fun Cooking Cards
- The Metric System

TV
- Metric Marmalade - Programs 12, 15

METRIC UNIT

Grade 5

Introduction to Metrics

Books

1 - pp. 1 - 6
6 - pp. 1 - 3
7 - p. 1
9 - A. M. 1 - 3
10 - pp. 3 - 8
11 - p. 5
12 - pp. 87 - 90
17 - p. 8
19 - pp. 1 - 10
21 - pp. iii - vi

Games, Charts, and Kits

Early Metric Books - The Metric System
Starting Points

TV

Measure to Measure - Program 3
Metric Marmalade - Program 2

Length

Books

1 - pp. 7 - 21
2 - pp. 10 - 12, 14 - 15
3 - pp. 12, 22
4 - pp. 1 - 5, 7 - 10, 12, 24
6 - pp. 4 - 10, 12 - 15, 17, 19 - 22
7 - pp. 2 - 7
8 - pp. (1 - 1) - (1 - 6), 1 - 9, 1 - 11
9 - A. M. 4 - 6
10 - pp. 12 - 19
11 - pp. 8 - 14, 25 - 26, 29, 93
12 - pp. 11 - 14, 19, 23, 26, 49 - 53, 78 - 80
13 - p. 4
16 - pp. 28, 39, 63
18 - pp. 92 - 94
19 - pp. 16, 19, 25, 55

Holt Math Book - pp. 326 - 328, 330

Games, Charts, and Kits
- Metrics I - Veri Tech
- Classroom Metric Lines
- Metric Mice - Length
- The Metric Box (L1 - L57)
- Centimetre by Centimetre
- Decimetre
- Early Metric Book - Meter
- Task Cards - Teacher's Handbook of Metric Activities (1 - 15)
- Metric Bag (L1 - L29)

TV
- Metric Marmalade - Programs 3 - 6

Perimeter

Books
- 2 - pp. 16, 21
- 3 - pp. 8 - 9
- 4 - p. 6
- 6 - p. 24
- 7 - pp. 18 - 19
- 8 - pp. (2 - 1) - (2 - 3)

Games, Charts, and Kits
- Task Cards - Teacher's Handbook of Metric Activities (16 - 19, 25 - 26)

Area

Books
- 1 - pp. 27 - 31
- 2 - pp. 21 - 22
- 6 - pp. 25 - 27, 29, 32
- 7 - pp. 20 - 23
- 8 - pp. 2 - 12
- 10 - p. 20
- 11 - pp. 48 - 52
- 14 - pp. NR24, NR26, LR27 - 28, NR35 - 37
- 17 - pp. 31 - 32, 36 - 37
- 18 - pp. 102 - 103
- 19 - pp. 36 - 38

Holt Math Book - p. 307

Games, Charts, and Kits
Metric Mice - Area
Task Cards - Teacher's Handbook of Metric Activities (16 - 24, 26)

Mass

Books
1 - pp. 44 - 49
2 - pp. 34, 36, 38
3 - p. 25
4 - pp. 14 - 15
6 - pp. 42 - 43, 49 - 50
7 - p. 42
9 - A. M. 10
10 - pp. 34 - 36
11 - pp. 75, 30 - 81, 83 - 84, 95
18 - p. 97

Games, Charts, and Kits
Metric Mice - Mass
Early Metric Book - Gram
The Metric Box (W1 - W53)
Task Cards - Teacher's Handbook of Metric Activities (27 - 40)
Metric Bag (M1 - M15)

TV
Metric Marmalade - Program 10

Volume

Books
1 - pp. 37 - 41, 52 - 55
2 - p. 29
3 - p. 24
4 - pp. 19 - 20
6 - pp. 34 - 36
7 - pp. 26 - 29, 33
9 - A. M. 8 - 9
10 - pp. 21 - 24
11 - pp. 72 - 74, 97
14 - pp. LR47 - 48
18 - pp. 104 - 106

Holt Math Book - p. 314

Games, Charts, and Kits
- Metric Mice - Volume
- Early Metric Book - Liter
- The Metric Box (V1 - V12)
- Task Cards - Teacher's Handbook of Metric Activities (41 - 55)

TV
- Metric Marmalade - Program 7

Temperature

Books
- 2 - pp. 40 - 42
- 3 - p. 48
- 6 - pp. 51 - 53
- 9 - A. M. 11
- 10 - pp. 39 - 41
- 11 - pp. 85 - 86
- 16 - pp. 91 - 92
- 21 - pp. 80 - 84

Games, Charts, and Kits
- Early Metric Book - Thermometer
- Task Cards - Teacher's Handbook of Metric Activities (56 - 61)
- Metric Bag (T1 - T4)

TV
- Metric Marmalade - Programs 8 - 9

Combination of Areas

Games, Charts, and Kits
- Hometrics Kit
- Metric Quizmo
- Metric Bingo
- Metric Playing Cards
- Metric Fun Posters
- Beginner's Metric System
- Metric Match
- Metric Market
- Metric Bag (A1 - A7)
- Metric Fun Activity Cards - Set B
- Going Metric
- The Good Apple Math Book - pp. 133 - 144
- Metric Fun Cooking Cards
- The Metric System

TV

Measure to Measure - Programs 2, 4, 5, 6
Metric Marmalade - Programs 12, 15

METRIC OLYMPICS-MEASUREMENT GAMES AND ACTIVITIES

The fundamental objective of the series of activities which follows is to present the metric system of measure to learners in a non-threatening manner via a game based laboratory approach. The students will hear the metric terms used properly while participating in team competition. No formal metric presentation is made during the activities but use of the terms and metric measuring devices facilitate later instruction.

Randomly divide the group into two or more teams of some convenient number (6-10 provide good activity levels). Strive to have the same number of students on each team. Every team must participate in each event. Although all team members will compete in some activities, no one will compete in all activities. When an event requires a limited number of participants from each team, "volunteers" are selected by the group. Suspense and hilarity can be inserted by choosing contestants before the event is described. In this case, any limitations as to dress or physical abilities would be stated prior to a team's designating its volunteers. Actually, a program can be established which has no special dress or physical requirements.

A spirit of competition can be generated by using a score board. Devise a system that awards a decreasing number of points as the team placement in an event decreases. For example, for three teams, first, second, and third places could be awarded three, two and one points, respectively. These points would be added and, at the end, the team with the largest total is the winner. There are sometimes advantages to going last and this can be spread around by having the teams do the next event in reverse order of finish from the last event. That is, if Team A finished first on event one, they go last on event two. If B was last on event one, they would go first on event two. In case of ties, an additional event can be used with only the tied teams participating. As events are used, you will need to make rule decisions commensurate with your group's disposition. Generally speaking, the sense of fun and fair play eliminates serious disagreements and your smooth reactions will do the rest.

The events to be used are dictated by your objectives. Metric Olympics was developed to provide examples of the following measures: linear, area, solid volume, liquid volume, and mass. This series of events has been done over 300 times with group sizes from 12 to 140. The age levels have been kindergarten through a group of 25 people whose average age was 75. Of course appropriate alterations might need to be made but the events are consistently well received.

If desired, a series of activities can be put together that would deal only with linear measure. The following activities can be combined to meet either of the forms mentioned. Similarly, events could be compiled to stress other areas of emphasis. The first six Metric Olympics activities can readily be done within an hour with a group of 30 students.

Standing Broad Jump

Participants must be able to jump for this event. Since a contestant might land in an awkward position, appropriate dress should be considered. Each team selects four (the number could vary) "volunteers" and then the event is named and the rules defined.

Several metre sticks are placed end to end on the floor forming a line segment. All jumpers use a two-foot take off and a two-foot landing. The first contestant's feet are placed so the toes are at the end of the first metre stick. That contestant jumps and the landing position of the toes is marked. The approximate jump distance is called out in terms of metres, centimetres, or millimetres. Strive to use all terms since familiarization with prefixes and units is one of the overall objectives.

The first person then steps aside and the toes of the second contestant are placed against the first person's marker. Then this second person jumps. And so it goes until each "volunteer" from that team has participated. The combined total is recorded and the next team is ready to jump. The winner will be the team having jumped the greatest total distance.

If there are several groups and if there is another leader available, one leader can start Team A on one side of the metre sticks while the other leader can follow with Team B on the other side. Then Team C can be done by the first leader, etc.

Total Foot Length

This event uses all team members. Each team is given a few metre sticks and told to find the combined length of their left feet. The contestants line up heel to toe. Only the left foot is used. The shortest length wins. This helps compensate for physical differences and injects considerable humor. Decisions involving shoes off or on, standing on toes, etc. must be made prior to the start. If the number of team members is different, some contestants should be designated to go twice. The selection must precede the description of the event.

Strongest Person

You will need centimetre grid paper and clay balls of the same mass. Each team selects two "volunteers". Instruct the two participants to remove rings, watches and jewelry. Place the ball of clay on the center of the paper. Each contestant is to hit the ball one time, striving to spread the ball over the largest possible area. Pressing and leaning on the ball are illegal. The clay must be hit with one blow per contestant. The fist may be open or closed. Participants should be cautioned about missing the ball. Some complaints can be eliminated by having new clay for each team but this is not absolutely necessary. In measuring the area, partial squares are combined with completely covered squares to give a total area. The largest area covered wins.

Liquid Volume

You will need water, paper towels, two containers, a small graduated cylinder and eye droppers. Two or more team members are to transfer water from the full container to the empty one using only the eye droppers. This is a time event (a minute or less). Amusement is often directly related to the number of contestants because of the confusion and collisions. When measuring, if the transferred water exceeds the capacity of the graduated cylinder, participants can be given a brief lesson in addition of millilitres.

Solid Volume

You will need centicubes and a cigar or shoe box. The volume of the box is to be estimated by all team members. The one result for each team is written on a piece of paper along with the team name. The closet approximation to the volume (either above or below) wins. All contestants should be kept at least three metres from a table on which the box and centicubes have been placed. Some of the centicubes can be put together to make various lengths to assist with the approximations. You should change the position of the box periodically. Team members may average individual estimates or they may discuss the dimensions and give their volume estimate. This activity provides a good basis for discussion about the merits of individual estimates being averaged and a normal curve as opposed to one estimate agreed upon by a group.

Mass

You will need a kilogram mass piece and a metric bathroom scale. Disguise the kilogram mass by putting it in a bag. Each contestant is isolated and asked to estimate their mass (weight) in terms of the mass in the bag. Once the estimate is recorded, the person steps on the scales and the value is read. The absolute value of the difference between the two results is recorded as the contestant's score. The team having the lowest score is the winner. If team size is not the same, contestants whose masses will be used more than once must be designated before the event is described.

Paper Plate Toss

This can be a total team event. Two team members will throw a paper plate at the same time. The objective is to throw the plate as far as possible since the greatest distance wins. The straight line distance between the take off and landing points is measured. Student participation can be increased by using more pairs from a team and conducting a relay, measuring the final straight line distance.

Straw Toss

This event can easily be done by all team members. Each person throws a drinking straw like a spear (no running or stepping start). A relay can be established by having the first person's landing point be the starting point for the second, etc. until all have participated. The final straight line distance is measured and the team with the greatest measure is the event winner.

Paper Airplanes

This event capitalizes on students' desire to make and fly paper planes. A team can have one member fly the team plane, each member fly the team plane or each member fly their own plane. The straight line distance between the starting point and the landing point is taken to determine the winner.

Punt, Pass, and Kick

You will need a large field and footballs (soccer balls). A line segment long enough to accommodate the desired number of participants should be placed on the field. Individual readings could be recorded and and then totaled, thus shortening the needed length for more than one person. A contestant passes (punts or kicks) the ball along the line segment as far as possible. The perpendicular distance the ball lands from the line is subtracted from the length of the toss. The result for each contestant on each part of the event is recorded. The team with the greatest total length is the winner.

Tiddly-Winks

You will need at least two small flat discs or metal flat washers. The player "snaps" one disc by pressing on its edge with the second disc. If this is conducted as a total team relay, the final straight line distance can be measured, giving the winner. Another way is to have contestants attempt to follow a line segment as closely as possible, subtracting the perpendicular distance from the line segment for each player (like in Punt, Pass, and Kick).

Marble Shoot

In this event, contestants shoot marbles as far as possible. Rules regarding "legal" shots need to be established prior to the event which can be done with individual "volunteers" or a total team relay. Accuracy can be stressed by requiring the shot to be as close to a pre-established line (like in Punt, Pass, and Kick).

Another variation would involve both directional and distance accuracy by having participants shoot at a point. The perpendicular distance off the line segment between the start and finish point would be recorded as would the distance between the stopping point of the marble and the pre-designated target point. The team with the smallest total deviation would win.

A similar event involving rolling a record down a line could be devised.

Linear Estimation

Any length estimation can be used. One suggestion would be to have each individual estimate the length of something to the nearest metre. The team average would then be computed for the team score. If the number of estimators is large enough, the average will be within one metre of the actual length being estimated. This provides an interesting and unusual way of introducing a normal curve and how it functions.

Estimate Liquid Volume

This activity is similar to "Solid Volume" in the original Metric Olympics. The only difference is that it must be explained that one centicube holds one millilitre of water at 4°C. The question then becomes how many millilitres the container holds. Difficulty can be varied by the size and shape of the container.

Another Mass

Frequently toward the end of an Olympics session, participants become reluctant to "volunteer". It is then that this particular event is most enjoyable. Each team submits a "volunteer" who is to go to the front of the room. Once all "volunteers" are there it is announced that they will do nothing but stand there while their combined mass is estimated. Each team will have one estimate recorded and the team closest to the actual value (above or below) wins first place. Estimation can be facilitated by passing a camouflaged kilogram mass around the estimators.

Square Metre

Since this event requires larger teams, you might need to combine the teams or divide the group into larger groups, have one home room challenge another, boys against the girls, etc. The objective is to see how many people can be fit inside the boundaries of a square metre marked on the floor. Establish the rules before starting. Both feet must be on the floor and inside the square before a person can be counted as being in the square. This will eliminate one student on another's shoulders.

Experience quickly shows that the space required for upper bodies exceeds that required for feet. At this point someone will think (don't tell them) to have four people place their feet along the sides of the square, hold hands and lean back, essentially getting their bodies outside the square while having their feet inside. Their weights will counterbalance each others, preventing falls. This idea can be used by two groups of four, making an eight pointed star around the square. Needless to say, this arrangement permits a group to get many more people into the square and win the event.

Scavenger Hunt

This event can use all team members. You will need to have standards and measuring devices that the students can use as a basis for comparison. Give each group a list of measurements and have them find a given number of those measurements in the room. For example, the list could contain 15 items and the group is to find any ten. The fastest group at finding ten items is the first place winner for the event.

The item list would include entries such as: 5 m, 17 cm, 500 g, 1 ℓ, etc. As a student finds an example of the measurement, the object name or a description should be written on the sheet. If possible and reasonable, the actual item could be returned for evaluation.

Shopping Assignment

Have students look for metric materials as they shop. You might designate a particular area (food, sports, fashion, sewing) and have the students find specific examples. The student could be required to find examples of particular units or prefixes. This could be done in the stores or via newspapers or catalogs.

METRIC UNITS

The following tables show the logical structure of SI units:

MASS

1 kilogram*	=	1000	grams
1 hectogram	=	100	grams
1 dekagram	=	10	grams
1 gram*	=	1	gram
1 decigram	=	0.1	gram
1 centigram	=	0.01	gram
1 milligram	=	0.001	gram

LENGTH

1 kilometre*	=	1000	metres
1 hectometre	=	100	metres
1 dekametre	=	10	metres
1 metre*	=	1	metre
1 decimetre	=	0.1	metre
1 centimetre*	=	0.01	metre
1 millimetre*	=	0.001	metre

VOLUME

1 hectolitre	=	100	litres
1 dekalitre	=	10	litres
1 litre*	=	1	litre
1 decilitre	=	0.1	litre
1 centilitre	=	0.01	litre
1 millilitre*	=	0.001	litre

*Units commonly used.

GUIDELINES FOR SPELLING, PUNCTUATION, AND THE USE OF SYMBOLS

1. Avoid capitalizing the commonly used SI unit names (except Celsius) unless they start a sentence.

   99 metres
   99 millimetres
   Metres measure length in the metric system.

2. SI symbols are both singular and plural.

   1 m
   100 m
   89 km

3. In writing and speech, use the metric prefixes only with a unit name.

   kilogram, not "kilo"

4. Use a lead zero to the left of the decimal point when the numerical unit is a partial unit.

   0.987 metre
   0.154 litre

5. SI symbols are not abbreviations and should not be followed by a period except at the end of a sentence.

   There are 90 m of ribbon in this pile.
   The distance from Springfield to Richmond is about 90 km.

6. When dividing, use an oblique stroke to separate the numerator and denominator.

   kilometres per hour = km/hr

7. Use a space to separate the digits of large numbers into groups of three. Commas are no longer used to separate groups of three digits because they are used as decimal markers in foreign countries.

three million two hundred twelve thousand twenty four metres
3 212 024

Digits to the right of the decimal point are also grouped in three and separated by a space.

0. 324 895 cm
0. 870 5 cm

8. When writing a numeral followed by a symbol, leave a space between the two.

45 m 678 mm 32 ml

9. Avoid mixing multiples of units when possible.

18. 78 metres instead of 18 metres 78 centimetres
45. 3 m instead of 45 m 30 cm or 45 m 300 mm

GLOSSARY

area: the size or amount of any surface

base unit: a unit of measure from which other units are formed

capacity: how much something can hold

Celsius thermometer: a thermometer calibrated so 0°C is the freezing point of water and 100°C is the boiling point

centi-: a prefix that means "hundredth"

centigram, cg: a unit of mass equal to 0.01 gram

centilitre, cl: a unit of capacity equal to 0.01 litre

centimetre, cm: a unit of length equal to 0.01 metre

cubic centimetre, cm^3: a unit of volume equivalent to the volume of a cube that is 1 centimetre on each edge

cubic decimetre, dm^3: a unit of volume equivalent to the volume of a cube that is 1 decimetre on each edge

cubic metre, m^3: a unit of volume equivalent to the volume of a cube that is 1 metre on each edge

deci-: a prefix that means "tenth"

decigram, dg: a unit of mass equal to 0.1 gram

decilitre, dl: a unit of capacity equal to 0.1 litre

decimetre, dm: a unit of length equal to 0.1 metre

degree Celsius, °C: a unit of measure of temperature on the Celsius thermometer

deka-: a prefix that means "ten"

dekagram, dag: a unit of mass equal to 10 grams

dekalitre, dal: a unit of capacity equal to 10 litres

dekametre, dam: a unit of length equal to 10 metres

gram, g: the mass of 1 cm^3 of water; a unit of mass equal to 0.001 kilogram

hectare: a unit of area containing 10 000 m^2

hecto-: a prefix that means "hundred"

hectogram, hg: a unit of mass equal to 100 grams

hectolitre, hl: a unit of capacity equal to 100 litres

hectometre, hm: a unit of length equal to 100 metres

kilo-: a prefix that means 1000

kilogram, kg: the mass of 1 dm^3 of water; a unit of mass equal to 1000 grams

kilolitre, kl: a unit of capacity equal to 1000 litres; the capacity of a cube that is 1 metre on each edge

kilometre, km: a unit of length equal to 1000 metres

litre, ℓ: a unit of capacity equal to the capacity of a cube that is 10 centimetres on each edge

mass: the measure of the amount of matter of which something is made

metre, m: the base unit of length

metric system: a decimal system of measurement with the metre as its basic unit

milli-: a prefix that means "thousandth"

milligram, mg: a unit of mass equal to 0.001 gram

millilitre, ml: a unit of capacity equal to 0.001 litre; the capacity equal to 0.001 litre; the capacity of a cube that is 1 centimetre on each edge

millimetre, mm: a unit of length that is equal to 0.001 metre

perimeter: the sum of the lengths of the sides of a polygon

square centimetre, cm^2 : a unit of area equivalent to a square region that is 1 centimetre on each side

square decimetre, dm^2 : a unit of area equivalent to a square region that is 1 decimetre on each side

square kilometre, km^2 : a unit of area equivalent to a square region that is 1 kilometre on each side

square metre, m^2 : a unit of area equivalent to a square region that is 1 metre on each side

square millimetre, mm^2 : a unit of area equivalent to a square region that is 1 millimetre on each side

temperature: how hot or cold something is

thermometer: an instrument used to measure temperature in degrees

volume: the amount of space that is taken up by something

weight: the measure of an object's mass

HISTORICAL STEPS TOWARD METRICATION

1670 Gabriel Mouton (a Lyons vicar generally regarded as the founder of the metric system) proposed a decimal system of weights and measures, defining its basic unit of length as a fraction of the length of a great circle of the earth.

1740 Preliminary calculations were made with a provisional form of a metre.

1790 A metric system of measurement was developed by the French Academy. The need for a uniform system of weights and measures was noted and discussed in the U.S. Congress, but no action was taken.

1795 France officially adopted a decimal system of measurement.

1798 A meeting was held in Paris to disseminate information about the metric system.

1799 The provisional metre and kilogram were replaced by newly established standards.

1821 A document was issued by John Quincy Adams exhaustively listing the advantages and disadvantages of both the English and metric systems; Adams concluded that "the time was not right."

1840 France made use of the metric system compulsory.

1866 Legislation made it "lawful throughout the U.S. to employ the weights and measures of the metric system." The system was not made mandatory, although this was anticipated.

1875 The "Treaty of the Metre," setting up well-defined metric standards for length and mass, was signed in Paris by seventeen nations, including the U.S. The International Bureau of Weights and Measures was established.

1880 Most of Europe and South America had gone metric.

1890 The U.S. received prototype metres and kilograms.

1893 The metric prototypes were declared by the Superintendent of Weights and Measures to be the "fundamental standards" for the U.S. ; other measures were defined in terms of the standard metre and kilogram. (Thus, the yard is legally defined as a fractional part of a metre and the pound as a fractional part of a kilogram.)

1918-29 Approximately forty bills on metrication were introduced in Congress, but no action was taken.

1959 Customary units were officially defined in terms of metric units.

1960 The metre was redefined in terms of a wavelength of light. The modernized metric system, the International System of Units (Système International d'Unités), referred to as SI, was established.

1965 Great Britain announced its intention to convert to the metric system.

1968 The U.S. Congress directed the Secretary of Commerce to undertake the three-year U.S. Metric Study, to evaluate the impact of the metric trend, and to consider alternatives for national policy.

1971 As a result of the metric study, it was recommended that the U.S. change to predominant use of the metric system through a coordinated national program.

1974 Public Law 93-380, Section 403 authorized a Metric Education Program to be managed by the U.S. Office of Education.

1975 Through the Metric Conversion Act the U.S. adopted a policy to plan and coordinate the increasing use of the metric system and to establish a Metric Board to coordinate the conversion to the metric system.

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COMMONLY LISTED ADVANTAGES OF THE METRIC SYSTEM

1. The metric system is a simple, logically planned system. Its decimal basis conforms to our numeration system.

2. The metre, which establishes the basis for the entire system, is always reproducible from natural phenomena and, therefore, is immune to destruction; it is international in character and well suited for precision work. The coordination of measures of length, area, volume and mass, combined with decimalization, facilitates computations.

3. Once the system of prefixes has been learned, the uniformity in names for all types of measures makes for greater simplicity and ease in changing to more convenient-sized units for specific purposes.

4. Although many of the claims of the amount of time that can be saved in learning fractions are probably exaggerated, less competence in the manipulation of common fractions would be required for many students, and some restructuring of time spent on such computation might be profitably accomplished. Ultimately, when only the metric system would be taught, time could be saved in the learning of conversion units (1 ft. = 12 in., 1 yd. = 3 ft., 1 rd. = 16½ft., 1 mi. = 5280 ft., and so on) and in the learning of a second new system for use in science classes.

5. For ordinary work, familiarity with the metre, gram, and litre would be sufficient. However, for the engineer and the scientist, the new International System of Units (SI) based on the metric units, eliminates conversion problems in calculations with derived units. That is, although power is universally defined as work per unit time, it is variously expressed in Btu/sec, therms/day, ft-lb/hr, horsepower, calories/sec, watts, and so on. The use of two different terms, kilogram and newton, for units of mass and force respectively, eliminates much of the confusion students have concerning these concepts.

6. Greater participation of the United States in the setting of international engineering standards would be possible since the metric system is the universal language of measure. Exports, foreign trade, and competition with other nations will depend more and more on production under metric standards.

7. A common measurement language that is used by scientists, engineers, and industrial workers would improve communication and reduce barriers between different sectors of society.

8. The necessity of conversion would offer fringe benefits. During the adjustment to the new measurements, there would be opportunities to eliminate superfluous varieties in sizes of products, parts, and containers, and to make additional worth-while changes in engineering standards, construction codes, and products design.

Arthur E. Hallerberg. A Metric Handbook. (National Council of Teachers of Mathematics), 1975

APPENDIX WW

MATERIALS TEACHERS RECEIVED DURING THE IN-SERVICE PROGRAM

American National Metric Council
1625 Massachusetts Avenue N.W.
Washington, D.C. 20036
Metric Guide to Educational Materials
The Metric System Day to Day

General Motors Corporation
Public Relations Staff
Detroit, Michigan 48202
The Swing to Metrics

J. J. Keller and Associates, Inc.
145 W. Wisconsin Avenue
Neenah, Wisconsin 54956
The Modernized Metric System Explained

Math-Master
P. O. Box 1911A
Big Spring, Texas 79720
Metric Handbook

National Bureau of Standards
U. S. Department of Commerce
Washington, D.C. 20234
"All You Will Need to Know about Metric"
"America Joins a Metric World"
"Brief History of Measurement System" and a Chart of the Modernized Metric System
Metric Conversion Card
What About Metric?

Sears Roebuck and Company
D1703, Sears Tower
Chicago, Illinois 60684
"An Educator's Guide to Teaching Metrication"
Metric Conversion and the Consumer

Virginia Department of Agriculture and Commerce
P. O. Box 1163
Richmond, Virginia 23209
"Think Metric"

Virginia Department of Education
P. O. Box 6Q
Richmond, Virginia 23216
"Everything You Wanted to Know about the Metric System but Were Afraid to Ask"
In-Service Guide to Teaching of Metric Measurement
Metric Cube
Metric Education Plan for Virginia
Metrics in the Kitchen
Metric Place Value and Table of Metric Measure
Prepare for a Metric Tomorrow
Temperature Chart

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